PRODUCTS finishing

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Business Routine

Elbert Hubbard once said that the paramount purpose of business is profits. During the period of war activity in the four years just passed, when emphasis was so great on production, it was easy to make profits. With the heavy volume of business in the war years, the greatest effort was expended in the obtaining of raw materials and man power to turn out orders. As normal conditions return, business men of the finishing industry can take stock and realize that once again competition will have to be met, and closer attention must be given to many other details.

One of these details is costs. Even when business is brisk, costs are important. We have heard a lot about ceilings in the past war years; however, with the termination of the war and to survive when goods are sold at competitive prices makes costs even more vital to profits. While costing is often considered mainly to be the function of an accountant, production men are also important in this field. It is quite likely that cost men more frequently consult with production men than vice versa. The production man may thus find it his duty to be somewhat versed in the elements of cost accounting.

Sometimes, production men have an antagonistic attitude toward cost systems. When called upon to furnish costs, often the lack of knowledge in the cost accounting field proves a handicap. Good production men should study up cost systems and be prepared to be of assistance when called upon for advice. It is to their advantage to do so. The successful operation of a good cost system requires the full coordination of all factory key men. Without this help it cannot operate properly. After the factory cost has been determined, the production man's duties with cost systems are usually over. Costs of administration and selling then become the duty of the accounting department.

It hardly need be said that unless a businessman knows the cost of his articles, he cannot operate a successful and profitable business.

Fig. 1—Jacks are suspended from conveyor prior to entrance into booth for electrostatic spraying.

Electrostatic Spray Process

By FRANK V. FAULHABER

CURRENTLY, the harassed and handicapped management of many a finishing plant is still lamenting and bewailing the difficulties besetting the obtainment of necessary finishing materials. Some establishments are more fortunate in achieving the desired finishing effects. Firstly, for their particular purposes they may be able to get the required materials; secondly, they may have experienced personnel who may know how to realize the most from the least, bringing about desired results through adept and expert experiment and manipulation. Meanwhile, wasteful and costly losses of finishing materials in some plants proceed flagrantly, unchecked.

Notably true is this of spray painting and finishing operations. Finishing establishments encumbered with out-dated spray-painting equipment are particularly outstanding violaters.

Inexperienced performance contributes materially to the delinquency, and this is further intensified by the frequent change of operators, with its incident necessity for breaking in new workers. Many managements understandably are so over burdened with their divers worrisome and perplexing operating problems that it is not entirely strange that this matter of finishing materials is not accorded its due consideration.

Many finishing plants use a dry type of spray booth. As with virtually any other type of work, one can gain a fairly accurate analysis of a spraying operator's proficiency by observing his spray booth. Sooner or later a spray booth must be cleaned, and cleaned properly, if its operation is not to be a drawback to the plant. When excess material, for instance, is permitted to accumulate on the exhaust fan blades, the efficiency of the equipment will be impaired.

Varied methods are employed to remove accumulations of finishing materials from a spray booth. It is necessary to strip off excess material by one means or another, and this frequent necessity entails the expenditure of more valuable time that might otherwise be employed. Paper of different kinds and other coverings are applied to the dry types of spray booths, in the interests of cleanliness and greater convenience of removal of the finishing materials that accumulate.

Nor is this necessity for stripping off the material accumulations from a spray booth unattended with dangers. When an employee uses a steel or iron scraper or other instrument likely to set off a spark, a serious fire is liable to result. The presence of an excess accumulation of wasted materials about a spray booth represents a distinct fire hazard.

In some shops, it is a policy to apply thinners and special solutions to loosen the hardened accumulations. Grease is also sometimes applied to facilitate cleaning of the spray booth, since its mixture with the overspray tends to keep the finishing material in a softened state. Whatever methods are followed, material is nevertheless being wasted, and the cleaning and other extra work thus necessitated are beset with other operating disadvantages. Apart from the fire hazard ever-present, an unclean spray booth frequently raises dust which settles on work being finished. When operators are required to spend too much time on cleaning, the shop's production schedule is seriously impeded.

With water-wash spray booths the management is enabled to reclaim finishing materials otherwise wasted. However, there is wide variance in the savings, depending again on the way the finish is being sprayed, how

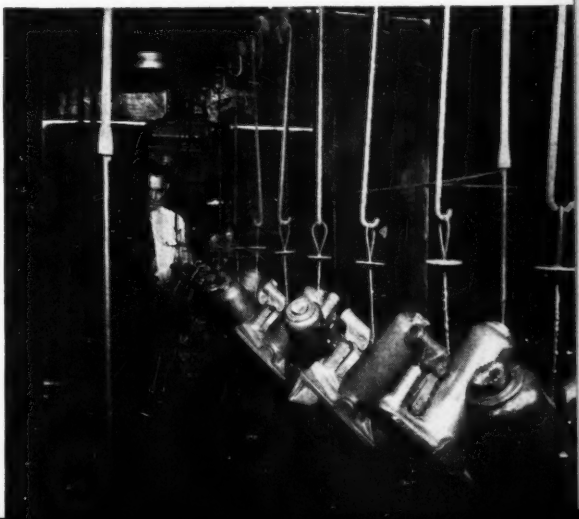

Fig. 2—The sprayed jacks emerge from the booth completely and evenly finished.

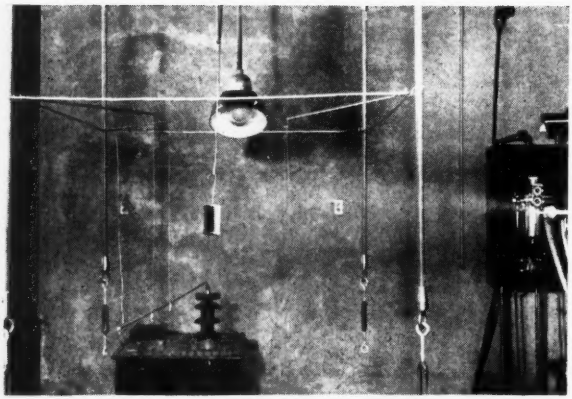

Fig. 3—The small fixed unevenly finished part shown herein has been sprayed without electrostatic field in operation for 5 seconds with white paint atomized by spray gun.

these oversprayed materials are taken care of, and the construction of the spray booth. Many times a spray booth is not designed appropriately for a plant's particular purposes. Each plant seems to have a different problem, peculiar to itself, and this is a detail always meriting uppermost consideration.

With a water-wash spray booth, however efficient the equipment may be, due care of the system also is necessarily entailed in the interest not only of the work being finished, but in anticipation of the maximum and proper recovery of the oversprayed finishing material. Many shops, with the best spraying systems in force, nevertheless never realize the full values of their waste materials. This failure to reclaim most of the oversprayed finishing materials can total to a staggering volume when we consider that in some shops on some operations the spray waste reaches as high as 80 per cent. When waste of finishing material attains such a costly volume, it indeed becomes a matter worthy of deep cogitation. The exigency becomes all the more pronounced in view of the problems confronting finishing plant executives puzzlingly trying to procure restricted and hard-to-get finishing materials.

A member of the Lockheed Aircraft Corporation, in discussing this huge organization's finishing methods informed the author that in the spray operation 40 percent of the material is lost, and yet no way has been found to relieve this loss. Lockheed paint shop heads say it would be a great thing if it were possible to have some spray equipment that could be used with no overspray, which at present cannot be controlled.

However, there is a bright picture on the horizon. Manufacturers in the past have been beset with finishing problems of one kind or another when processing their products by spray methods. One complaint is occasioned by the lack of uniformity on items where a smooth, even film is particularly to be desired. In manual spray operations especially, where the coating applied is governed materially by the experience and proficiency of the operator, there often is a noticeable variance in the finishing. Apart from the unevenness of application, the finished work often shows runs and sags and other objectionable deficiencies.

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the author regarding its operating procedures, advantages, and efficiencies. In discussing its various benefits, he pointed out the process, which has been developed only within the past few years, has been very successful in substantially overcoming two of the most serious handicaps of spray finishing. The system accomplishes these very worthwhile purposes by effecting a large saving in material waste and contributes toward a more uniform film. Production runs conducted with porcelain enamel on stove panels indicated that 30 per cent of the material used on cover coat in the stove industry can be saved. The degree of savings possible is largely determined by the shape and size of the units being finished.

As with practically any technical finishing process, this new spraying system naturally is not wholly without its limitations. As with electroplating, for instance, protruding edges and recessed sections are difficult or impossible to finish uniformly. This does not necessarily imply that the unit under finish must be perfectly smooth. Instead, it is to be viewed as an obstacle toward obtaining the desired film uniformity. Necessarily, of course, a certain volume of repetitive production is entailed before it would be feasible to install the highly specialized equipment essential for the process.

Noteworthily, a number of similarities and a number of dissimilarities stand out between this novel spraying process and conventional electroplating. With this new method, the grounded article being sprayed is surrounded by an electric field. The arrangement is intended to communicate an electric charge on the sprayed particles in such a manner as to magnetize the particles to the article being coated. The correct electric current is furnished by a power pack especially designed to develop a high voltage of around 100,000 volts and a very low amperage, limited to 10 milliamperes.

In operating this novel spraying system, direct current is required, although satisfactory results can be obtained with virtually any rectified wave form. Diligent experiments have proved that a pulsating one half wave is as efficacious as any, and considerably more satisfactory than some other wave forms. Verily, the volume of current consumed is nominal, and in no case is it expected to require more than four or five milliamperes on the secondary.

Requisite it is, however, that an adequate amount of current be fed to the electrodes. This desired condition can be brought about on any installation by carefully designing the lead-in conveying the current from the power pack to the electrodes, thereby to alleviate the leakage from the lead-in conductor.

It is interesting to note that the electrodes which surround the grounded unit are designed of sharp points or wires. These are set at desirable intervals from the article and from each other in such a manner as to achieve the necessary intensity and direction of impulse to the field established. It is necessary that the entire proportion of surface area of the electrodes be decidedly small in comparison to the area of the piece directly opposite the electrodes. Significantly, though, when this principle is overdone, the performance of the process is not so satisfactory.

A practical policy which has been followed with satisfactory results is the one of employing a series of No. 30 copper wires on the installations, suspending these vertically and spacing them 10 to 12 inches from each other with the complete electrode arrangement 11 inches from the article to be finished. When operating with

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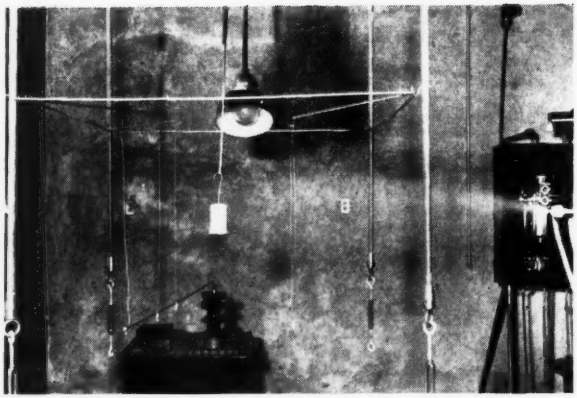

Fig. 4—Using the same white paint and applying time, the part shown in Fig. 3 is sprayed with electrostatic field in operation, a uniform coating being obtained.

100,000 volts, this setup has proved to be the most effective, considering the specific requirements desirable for such a spraying system.

What about the spray guns in use, the air pressure and the finishing vehicles required in adopting this unique method? The interested finishing plant executive naturally keenly questions. It might be stated that the guns required are of a standard type, air operated and automatic, chosen for their ability to atomize painting fluids sufficiently when working with comparatively low air pressure. As to the composition of the paint and the air pressure, these vary considerably, as under other finishing methods, according to the character of product being sprayed and the rapidity of operation sought. For most purposes, under this system, however, approximately 10 lb. atomizing pressure and a fluid pressure hovering around 1 lb. will assure satisfying results.

It should be borne in mind, however, that the fact that these pressures are not fixed affords no ground for the assumption that there may be wide limitations upon these factors. Nevertheless, it is well to ponder that as the flow of the paint is altered compatible with the job under hand, other details having bearing require attention; namely, the fluid tip size, the atomizing pressure, and the fluid pressure which necessarily must be varied for maximum operating performance.

A clearer conception of this may be obtained by considering the importance of correlating the inertia of the paint particle with the intensity of the electric field through which it is moving. To an extent, the positions of the spray guns are determined by the individual application. However, in all cases where it is desired to save considerable paint material, it is imperative that the axis of the spray be directed at an acute angle to the line of travel of the articles on the conveyor. Ordinarily, an angle of 15 deg. is in force.

Relevantly, this factor is highly important by reason of the wide variety of particle sizes resulting from the spray guns that were tested. Patently, a varying time will be entailed for the field to overcome their original inertia and direct them to the piece being sprayed, since there is a diversity in size and inertia at a given distance from the spray gun proper.

When operating such a spraying system, it is usually best to maintain the spray gun in continuous performance. The articles proceed steadily through the field, each acquiring its share of coating material. In a situation where it is unfeasible to have an uninterrupted flow of products through the coating area, the operation may be facilitated by employ-

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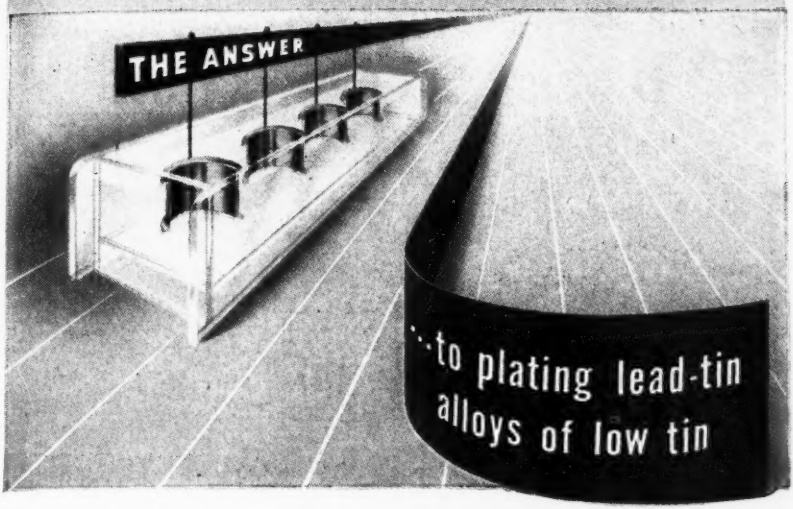

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ing an electric eye or a timing relay for actuating a magnetic air valve which in turn operates the spray guns.

In Fig. 1 can be noted the simplification of this electrostatic spray method. The operator is suspending jacks from the conveyor preliminarily to entrance into the control cabinet at the right. For this work no more than 6 lb. air pressure is required at the spray guns, affording an idea of the paint-saving possibilities—exactly 50 per cent to be precise, on these jacks.

Referring to Fig. 2, the sprayed jacks can be observed issuing from the booth, with uniform finish. This is particularly significant since these jacks, with their irregularity of outline, can hardly be categoried as an ideal product for electrostatic spraying.

Inside the spray chamber, the jacks are made to revolve within the electrostatic field. Notably, the spray guns are not focused directly at the units, but rather in an almost parallel direction. As is the object, the paint particles are drawn uniformly to all surfaces of the rotating jacks. As the finished jacks emerge, they are dry enough to permit handling by the time they reach the removal station, ready to be skidded away for packing and shipping, with very little inspection being involved.

Figure 3 provides a laboratory demonstration of this spraying system, a small fixed cylinder being sprayed without electrostatic field in operation for five seconds with white paint atomized by the spray gun. Figure 4 shows the cylinder after being sprayed with electrostatic field in operation, using the same white paint and applying time as that in Figure 3.

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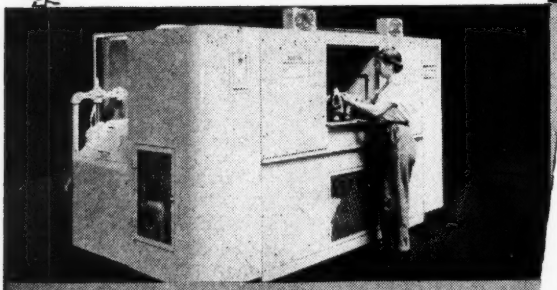

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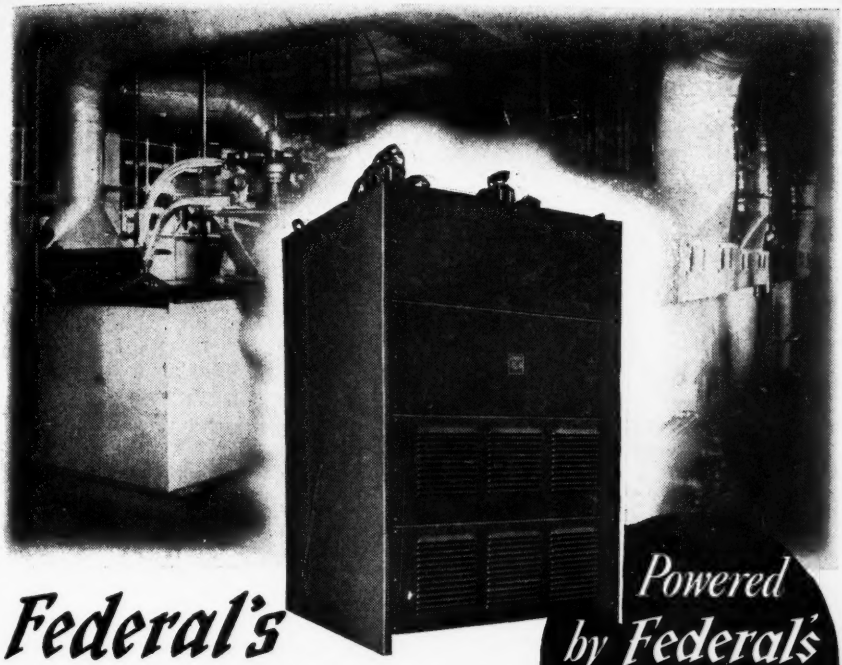

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pH

In this article the author endeavors to cover in considerable detail the significance, measurement, etc., of pH.

By BRYANT W. POCOCK

WHEN a few years ago it was established that hydrogen ion concentration must play an extremely important role in most chemical reactions, a scheme was devised whereby the concentrations of hydrogen ions could be evpressed as simple numbers. These numbers are now familiar to us all as the well-known numbers from 1 to 14 which comprise our pH scale. How they came to be chosen and what they really mean is something which every metal finisher should know.

In setting up this scheme of simple numbers, a scale had to be adopted with the greatest practicable hydrogen ion concentration at one end, just as an ordinary thermometer is expected to go up to the highest temperature which that thermometer will ever be called upon to record. When it came to deciding what should be at the other end of the scale, however, it wasn't quite so simple. Should the bottom of the scale be made to represent zero concentration of hydrogen ions? If so, would there ever be occasion to go below zero as in temperature measurements?

In order to arrive at a satisfactory scheme, all possible contingencies were examined. One of the first of these involved the fundamental concept, what do we mean by hydrogen ion concentration? The answer to this was of course that hydrogen ion concentration has a direct bearing upon strength of acidity. The more hydrogen ions, the more strongly acid a solution is. A strong acid is one that ionizes strongly, furnishing a large number of hydrogen ions.

But why confine our thinking entirely to acidity? Is the converse not also true of bases? The more strongly basic a solution is, the more strongly ionized and the more hydroxyl or (OH^-) ions are present. And, since hydroxyl ions unite with hydrogen ions to form water, which is neither basic nor acid but neutral, each ion may be looked upon as the complement to or opposite of the other.

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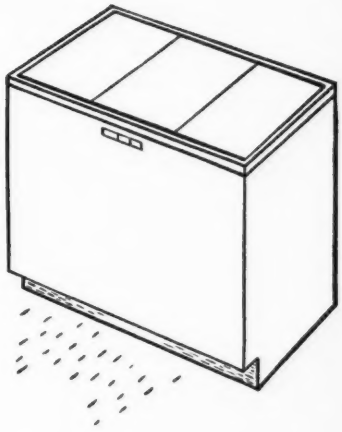

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and the answer to our question what to put at the other end of the scale. The scale was set up with the greatest practicable number of hydrogen ions at one end, the greatest practicable number of hydroxyl ions at the other, and with exact neutrality at the midpoint. So much for the scheme; now what about the values?

It was determined by very precise and accurate measurements that absolutely pure water, H_2O, has one molecule in about 555,000,000 dissociated or split up into a hydrogen ion (H^+) and a hydroxyl ion (OH^-) which are available to carry an electric current. This is not very much and the current must be a feeble one, but nevertheless it is so. Another way of saying the same thing is to state that a liter of pure water at 25°C. contains $\frac{1}{10,000,000}$ gram of hydrogen ions. The logarithm of 10,000,000 is 7, which, to get ahead of our story, is the reason why the pH of pure water is 7.

Long before all this was discovered a certain chemical law was known which was now picked up and applied to the case at hand. This law was known as the Law of Mass Action. According to it, in a given quantity of water at a given temperature, the product of the hydrogen and hydroxyl ions may be regarded as practically constant. This constant, K_ω, is called the dissociation constant of water. Several different methods of determining this fundamental quantity have given it the value $\frac{1}{100,000,000,000,000}$ at 25°C. This value can be expressed in a much more convenient form as $\frac{1}{10^{14}}$ or simply as 10^{-14}.

Our reasoning tells us that since water is exactly neutral, the number of (H^+) ions must equal the number of (OH^-) ions. If $(H^+) = (OH^-)$ and $(H^+)(OH^-) = 10^{-14}$, then $(H^+) = 10^{-7}$ and $(OH^-) = 10^{-7}$. In the case of any solution which is neutral, $(H^+) = (OH^-) = 10^{-7}$. Solutions in which (H^+) is greater than (OH^-) have (H^+) greater than the magnitude 10^{-7} and are acid. Note that in such cases the exponent becomes smaller numerically. Solutions in which (OH^-) is greater than (H^+) have (OH^-) greater than the magnitude 10^{-7} and are basic.

But if we write out mathematically the equation $(H^+)(OH^-) = K_\omega$, we may get by transposing the fact that $(H^+) = \frac{K_\omega}{(OH^-)}$. In other words, (H^+) varies inversely as (OH^-) and can be used to express values of hydroxyl ion concentration as well as those of hydrogen ion concentration.

As in astronomy, which deals with enormous magnitudes, we have found it convenient here in speaking of infinitesimally small numbers to adopt shorter symbols for the cumbersome though familiar terms of everyday arithmetic. It was Sørenson who proposed that we express hydrogen ion concentrations as negative logarithms to the base 10. These he called pH values, pH being the logarithm to the base 10 of the reciprocal of the hydrogen ion concentration, or the negative logarithm to the base 10 of the hydrogen ion concentration, whichever way you wish to look at it. In either case the hydrogen ion concentration is given in grams per liter, and this is important in relating pH with normality. Mathematically, therefore, $(H^+) = 10^{-pH}$.

A neutral solution such as water would have a hydrogen ion concentration, $(H^+) = 10^{-7}$. Its pH would therefore be 7. This constitutes the midpoint of our scale. A pH numerically less than 7 denotes an acid solution. If the pH is numerically higher than 7, the solution is basic. It is important to

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keep in mind that an increase in pH, say from pH 5.0 to pH 6.0, means that at 6.0 there is one-tenth less concentration of hydrogen ions than was the case at pH 5.0. Let us see how Sørensen's idea has shortened our terminology.

An acid is said to be normal with respect to hydrogen ions if it contains 1 gram of hydrogen ions per liter. If it contains one-tenth of this amount, it is tenth normal. In the case of a tenth normal soluion of acid, the hydrogen ion concentration would be $(H^+) = 0.1$.

The reciprocal of this would be $\frac{1}{0.1}$ which of course is the same thing as 10. Inasmuch as the logarithm to the base 10 of 10 is 1, the pH of a tenth normal solution of acid would be 1. If the acid were hundreth normal with respect to hydrogen ions, the pH would be 2.0, and so on, until pH 14.0 is reached. One unit of pH corresponds to a tenth more or less concentration of hydrogen ions than the preceding unit, with the advantage that small numbers are used. This can be appreciated when we stop to consider that pH 14.0 corresponds to a hydrogen ion concentration of 0.000,000,000,000,01.

The Significance of pH

Accurate measurement and ajustment of pH as a means of controlling and regulating hydrogen ion concentration first received widespread recognition in the fields of bacteriology and physiological chemistry, with which sciences the concept of pH may be said to have grown hand in hand. As early as 1920 it was realized that the then common practices of adjusting the reaction of bacteriological media by titration with phenolphthalein indicator was illogical for the simple reason that phenolphthalein changes color between pH 8.0 and pH

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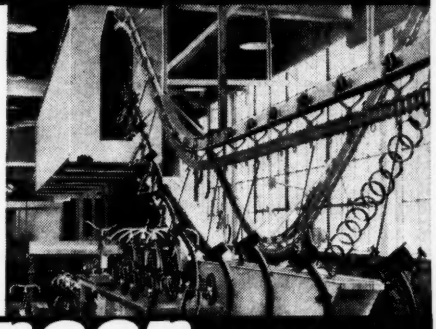

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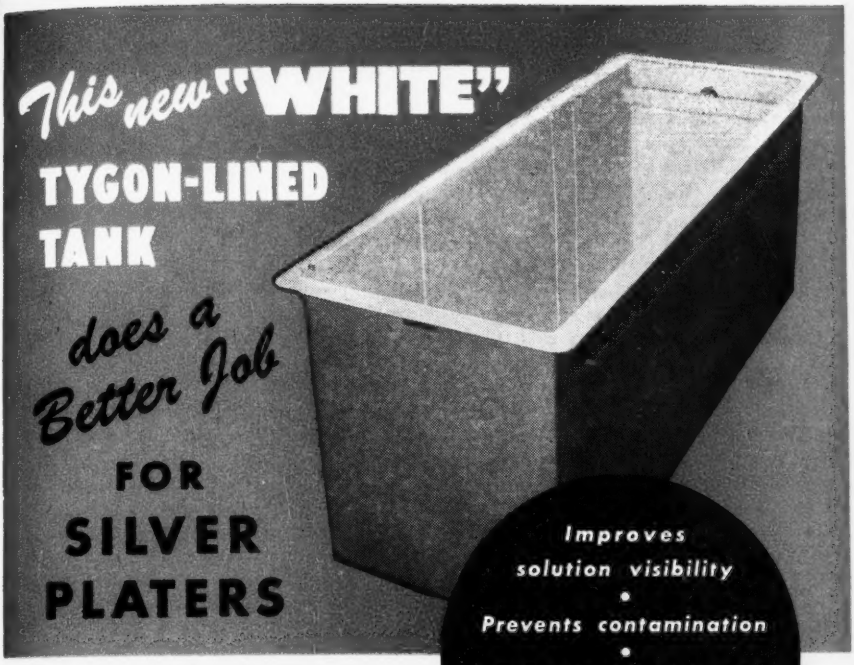

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10.0. By 1925 it was generally conceded that some bacteria require for optimum growth media whose pH must be maintained accurately to the second decimal. Moreover, tiration gives no indication of the strength or quality of acidity in terms of hydrogen ion concentration.

It was soon discovered that the pH of soil must lie between 3 and 10 for it to possess any fertility at all. Soil as acid as pH 1.7 has been found in America, as alkaline as pH 11 in Egypt. Chemists learned that sugar beets grow best when the soil is between pH 6 and 8, that flax requires soil from pH 4 to pH 6. They learned that plant tissues have an average pH of 5.2 and that the pH of gastric juice approaches 1. They discovered that steel corrodes in soil five times as rapidly at pH 4.5 as it does at pH 11.6. Sea water was found to have a pH of 7.75 to 8.25.

Of great significance to the electroplater are the modern specifications for hydrogen ion concentration of his plating solutions. Some of the most important of these specifications are given in the following table:

Hydrogen Ion Concentrations of Plating Solutions

Solution	pH
Cadmium	12 approx.
Chromium	Very low
Copper, Rochelle salt-cyanide	12.2 to 12.8
Iron	
Hot chloride solution (1)	1.5 to 2.5
Hot chloride solution (2)	0.6 to 1.0
Room temp. chloride	5.0 to 5.5
Sulfate bath	5.0 to 5.5
Lead, fluoborate	Very low
Nickel, general	5.4 to 6.0
Warm nickel, Watts type	5.2 to 5.8
Hard nickel	5.6 to 5.9
Black nickel (1)	5.8 to 6.1
Black nickel (2)	5.6 to 5.9
Palladium	
Diammino-nitrite bath	7 approx.
Sodium palladium nitrite bath	4.0 to 5.0
Acid chloride bath	0 to 0.5
Platinum	7 approx.
Silver	11.5 to 12.0
Tin, acid	Very low
Zinc, acid	
Still plating	3.5 to 4.6
Barrel plating	5.0 to 5.3
Zinc, cyanide	12.2 to 12.7

It is common experience that iron, nickel and zinc deposits become brighter when the pH is low, and in the case of nickel a sudden brightening of the deposit is often taken as a warning of the danger of cracked or curled deposits. Conversely, a high pH produces a bright deposit with the Rochelle salt copper cyanide bath.

Buffers

It is thus seen that it is very frequently desired to maintain the hydrogen ion concentration or pH of a solution within certain relatively narrow limits, as in the above table. Dame Nature seems to have endowed all living things with automatic, foolproof mechanisms for the maintenance of pH with hair-splitting accuracy. The pH of human blood is 7.328. If it fails much below that amount we get sick from acidosis; if it rises appreciably we get sick from alkalosis. The organism Brucella, which causes undulant fever, must have a pH of 6.8 for optimum growth, which is one very good reason why it inhabits milk and why human undulant fever victims frequently outlive their disease. Yeasts require pH 4 to pH 5.5. Vibro comma, the causal agent of Asiatic cholera, will ultimately die unless the pH of its environment is kept between 8.0 and 9.0, which is a very good thing for us indeed.

How does it happen that the pH of living tissues is held so constant? Surely no one of us have ever knowingly concentrated during his waking hours on maintaining the hydrogen ion concentration of his blood at pH 7.328. Is there some mysterious force which does this for us, which when understood can be made to serve us still

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Drying time is much shorter, permitting wheels or belts to be put back into service more quickly, thus reducing the necessary inventory of such wheels or belts. In many plants, this is a very important factor, reducing the space occupied, and the investment.
Whereas, the overheating of glue, either in preparation, curing, or polishing operations, is very destructive, the same temperatures and conditions have little, if any, injurious effect on Stevens Abrasive Cement. It does not become brittle nor lose its adhesive properties, but still bonds the grain to the wheel or belt. Heat hardens Abrasive Cement, whereas it softens glue.
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You can try out Stevens Abrasive Cement on your own job and determine whether the advantages usually realized will be found in your own plant. We will send you a quart can for testing, upon request.

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There is such a force, but it is no longer mysterious. It is in effect a chemical needle valve, its action being wrought by what are known as buffers. Buffers in living tissues are usually proteins, amino acids and salts. In the chemical industry they may be mixtures of any weak acid and its salt. An example might be acetic acid and sodium acetate.

Acetic acid, the essential ingredient of vinegar, is only very slightly ionized in water. When it is dissolved most of it remains in solution in the form of molecules, but a few of these break up into hydrogen (H^+) and acetate (Ac^-) ions. If some sodium acetate is now dissolved in this solution, very few of its molecules remain whole, most of them splitting up into sodium (Na^+) and acetate (Ac^-) ions.

Now, there is only a certain concentration (pH) of hydrogen ions present in such a mixed solution. Except for the microscopic amount always present in pure water, all of the rest come from the acetic acid. Suppose that we now add some hydrocholoric acid, HCl which ionizes strongly and furnishes a lot more ions. These hydrogen ions from the hydrochloric acid immediately combine with the acetate ions from the sodium acetate to form molecules of acetic acid, which step right out of the picture so far as hydrogen ion concentration or pH is concerned, because they ionize to such a very low extent. Therefore, it is possible to add considerable quantities of strong acid to such buffer solutions without materially lowering their pH.

If instead of HCl, sodium hydroxide, NaOH, is added, this base likewise ionizing strongly, a large number of sodium (Na^+) and hydroxyl (OH^-) ions will be produced. The (OH^-) ions immediately combine with the (H^+) ions to form relatively undissociated water, but that doesn't make much difference because there are only a few (H^+) ions anyway. If there are many (OH^-) ions left over, they will soon have more (H^+) ions to combine with from the acetic acid, more of which becomes ionized. Thus, it is possible to add considerable quantities of strong base to such buffer solutions without materially raising their pH.

It is by means of these very wonderful and extremely fortunate throttling properties of chemical buffers that we are enabled to adjust chemical solutions to desired pH values and keep them there. All we have to do is select the proper buffers from among the many hundreds which exist. Scott (p. 2281) cites the following common buffer systems:

Buffer	pH
Glycocoll-sodium chloride-hydrochloric acid	2.0
Potassium acid phthalate-hydrochloric acid	2.8
Primary potassium citrate	3.7
Acetic acid-sodium acetate	4.6
Potassium acid phthalate-sodium hydroxide	5.0
Secondary sodium citrate	5.0
Carbonic acid-bicarbonate	6.5
Primary phosphate-secondary phosphate	6.8
Primary phosphate-sodium hydroxide	6.8
Boric acid-borax	8.5
Borax	9.2
Boric acid-sodium hydroxide	9.2
Bicarbonate-carbonate	10.2
Secondary phosphate-sodium hydroxide	11.5

(The concluding section of this article will be published in the April issue of PRODUCTS FINISHING)

"Specification Index for Bristol Instruments" is the title of a 24-page catalog published by The Bristol Co., Waterbury 91, Conn. Designated as the No. W1800, the catalog contains information on the Bristol line of automatic controlling, recording, and indicating instruments and provides hints on how they can be used effectively to save time and promote efficient operation. Specification data are provided on each instrument listed, and the catalog is well illustrated with line drawings which show basic methods of applying various types of industrial instruments. Copy free upon request.

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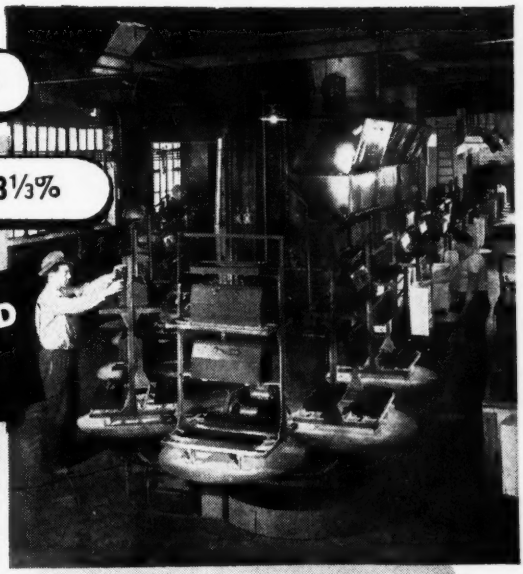

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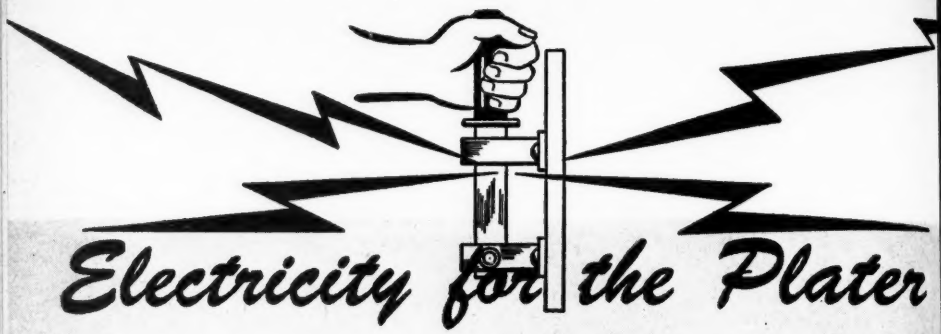


Electricity for the Plater

D. A. COTTON

Part VIII

MICHAEL FARADAY'S discoveries in the field of electromagnetism were not his only contribution to the science of electricity in general and of electroplating in particular. Sometime during the period from 1833 to 1835, he made known the principles governing the relation between weight of metal deposited and quantity of electricity, which are called Faraday's laws.

It will first be desirable to clarify the meaning of some of the terms that will be encountered in dealing with this subject. So far, the discussions have dealt with metallic conductors. However, electroplating involves solutions of various chemicals from which metals are released by the passage of an electric current through them. In order that current may flow through the plating baths, the solutions must be conductive.

So far as the plater is concerned, the process of passing an electric current through a solution is called electrolysis. A liquid conductor, such as a plating bath, is called an electrolyte.

Faraday's laws may be expressed in many different forms such as:

(a) During electrolysis equal weights of electrolyte are decomposed at each electrode by equal quantities of electricity.

(b) The weights of different elements released by equal quantities of electricity are proportional to their equivalent weights.

This series of articles is concerned only with the expression of these principles in such form as to enable the plater to calculate how much metal he can expect to plate with a given amount of current in a given time. Therefore, the laws as stated in (a) and (b) will be changed to read as follows:

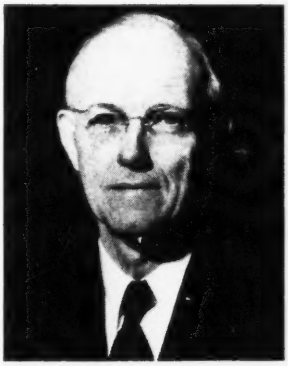
(1) The weight of metal deposited is directly proportional to the product of the current and the time.

(2) The weight of metal or element deposited by any given quantity of electricity is directly proportional to the atomic weight of the element and inversely proportional to its valence.

Considering part (1) of this law and recalling the definitions of some of the electrical units discussed in Part II, the product of current in amperes, **I**, and of time in seconds, **t**, gives the quantity of electricity in coulombs.

(Coulombs are ampere-seconds.)

It is important to note here that the weight of metal deposited depends upon the **product** of current and time and that it makes no difference so far as weight of metal is concerned whether the current or time is great or small in value so long as one varies inversely with the other. That is, a current of 100 amperes flowing for 10 seconds will produce the same results as 50 amperes for 20 seconds or 10 amperes for 100 seconds.



D. A. COTTON

It is obvious that all that is needed in (1) is a constant relating quantity of electricity directly with weight of metal in order to express this law very simply as $w = kIt$, where **w** is weight of metal plated in grams, **I** is current in amperes, **t** is plating time in seconds, and **k** is grams of metal plated per coulomb (**It** = coulombs). This constant **k** is called electrochemical equivalent and varies in value for the different elements. It will be time well spent to show how this electrochemical equivalent is derived.

Part (2) of Faraday's law as stated above contains some of the clues necessary for deriving the values of electrochemical equivalents. But first, a few words may be needed concerning some of the terms used in the statement of part (2).

Many series of articles on chemistry for the plater have appeared in print, such as, for instance, those written by Dr. C. B. F. Young and published not so long ago in PRODUCTS FINISHING. These have explained the meaning of such terms as atomic weight and valence, therefore, it should not be necessary to dwell on them at length in this discussion. Suffice it to state that to each element has been assigned a number representing the relative weight of the element which enters into combination with other elements to form chemical compounds.

Hydrogen, which is the lightest element, was originally made the basis of comparison and was given the atomic weight of 1. However, the present system is based on oxygen with an atomic weight of 16, and, on this basis hydrogen is 1.008.

As for the term valence, the plater is not so much concerned with knowing its technical meaning as in having easily available a table showing the valence numbers of the various elements. However, for this discussion of Faraday's laws, valence may be defined as the number of bonds per atom of an element which hold it in combination with another element. Or, since the valence of hydrogen is always 1, the valences of elements may be more simply defined as the number of atoms of hydrogen which the element will replace or with which it will combine.

For example, the chemical symbols for nitric, sulfuric, and hydrochloric acids are HNO_3, H_2SO_4, and HCl respectively. The symbol for silver nitrate is $AgNO_3$; for copper sulfate, is $CuSO_4$; for aluminum chloride, is $AlCl_3$. Therefore, the valence of silver is 1, that of copper 2, and that of aluminum 3. Stated another way, silver is monovalent, copper is bivalent, and aluminum is trivalent. Some elements have more than one valence as, for instance, copper which, in the form of copper cyanide, CuCN, is monovalent.

TABLE V

1	2	3	4	5	6	7	8	9
				Electrochemical Equivalent			Grams per sq. in.	
Element	Atomic Weight	Valence	Equivalent Weight	g./coulomb	g./amp. hr.	Spec. Grav.	per 0.001 in.	Amp. hr. for 0.001 in. per sq. in.
Cadmium	112.41	2	56.20	0.000582	2.097	9.7	0.1409	0.0674
Chromium	52.01	3	17.34	0.000180	.647	7.1	0.1164	0.1786
Chromium	52.01	6	8.67	0.000090	.323	7.1	0.1164	0.3572
Cobalt	58.94	2	29.47	0.000305	1.100	8.9	0.1459	0.1326
Copper	63.57	1	63.57	0.000659	2.372	8.9	0.1459	0.0615
Copper	63.57	2	31.78	0.000329	1.186	8.9	0.1459	0.1231
Gold	197.20	1	197.20	0.002044	7.358	19.3	0.3163	0.0431
Hydrogen	1.008	1	1.008	0.000010	.0376	.....	.....	.....
Indium	114.76	3	38.25	0.000396	1.427	7.3	0.1197	0.0843
Iron	55.85	2	27.98	0.000289	1.042	7.9	0.1294	0.1243
Lead	207.21	2	103.61	0.001074	3.866	11.3	0.1852	0.0465
Nickel	58.69	2	29.35	0.000304	1.095	8.9	0.1459	0.1333
Oxygen	16.00	2	8.00	0.000083	.2985	.....	.....	.....
Rhodium	102.91	3	34.30	0.000355	1.066	12.4	0.2032	0.1903
Silver	107.88	1	107.88	0.001118	4.025	10.5	0.1721	0.0431
Tin	118.70	2	59.35	0.000615	2.215	7.3	0.1197	0.0542
Tin	118.70	4	29.68	0.000308	1.108	7.3	0.1197	0.1084
Zinc	65.38	2	32.69	0.000339	1.219	7.1	0.1164	0.0951

Note:

Owing to the lack of space for headings of columns of Table V, the following explanations are given.

Column 5 gives the constant *k* in grams metal per coulomb.

Column 6 gives the constant *k* in grams metal per ampere-hour.

Column 7 is the weight in grams of a cubic centimeter of the metal.

Column 8 gives the weight in grams of a piece of the metal 0.001 inch thick and having 1 square inch area.

Column 9 gives the ampere-hours required to plate 1 square inch surface with 0.001 inch of metal.

To obtain ampere-hours required to plate 0.001 inch per square foot surface, multiply the values in Column 9 by 144.

At this point, another chemical term should be defined. The equivalent weight of an element is its atomic weight divided by valence. Thus, the equivalent weight of a monovalent element would be equal to its atomic weight; of a bivalent element, one-half its atomic weight, and so on.

Returning to the subject of electrochemical equivalents, in Part II the ampere was defined as the current which will in one second deposit 0.001118 gram of silver from a silver nitrate solution. Since one ampere-second is one coulomb, then 0.001118 gram of silver is deposited per coulomb of electricity.

It is seen from Table V that the equivalent weight of silver is 107.88 grams. It would require then $\frac{107.88}{0.001118}$ or 96,493 coulombs of electricity to deposit an equivalent weight of silver. Faraday first demonstrated this fact and later found that copper was deposited from a copper sulfate solution at the rate of 0.0003294 gram per coulomb. This also gives $\frac{63.57}{2 \times 0.0003294}$ = 96,493 coulombs per equivalent weight of copper.

From these and other experiments, he finally deduced the general law that the quantity of electricity equal to 96,500 coulombs will deposit equivalent weights of elements. For this reason, the quantity 96,500 coulombs has been given the name faraday.

Note that the statement of Faraday's law given previously in (b) is exactly equivalent to the one given in (2), since atomic weight divided by

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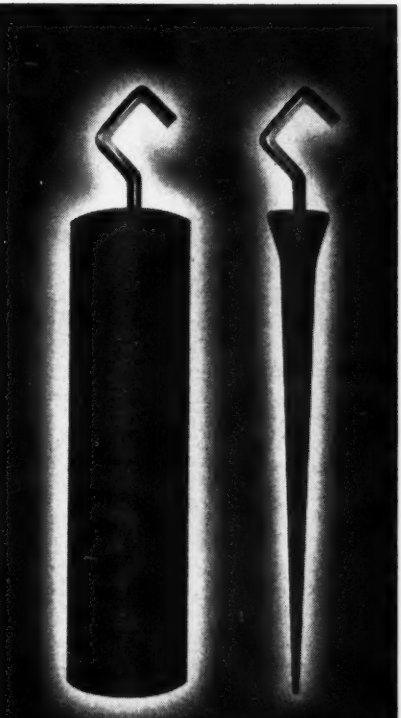

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valence is equivalent weight.

Returning to the mathematical statement of the law given previously, $w = kIt$, note if **w** is taken as the equivalent weight of an element and the quantity of electricity, **It**, is a faraday, 95,500 coulombs, then $k = \frac{w}{It} = \frac{w}{96{,}500}$.

It is thus evident that the electrochemical equivalent of an element is simply its equivalent weight divided by 96,500. Also, since equivalent weight is atomic weight divided by valence, the electrochemical equivalent is atomic weight divided by the product of valence and 96,500 or $k = \frac{a}{v \times 96{,}500}$ where **a** and **v** are atomic weight and valence respectively.

Having a table of electrochemical equivalents or having calculated this equivalent for any element, the weight plated by any quantity of electricity will be found by $w = kIt$.

Example 1: What weight of silver will be plated in 30 minutes by a current of 5 amperes?

Solution: $w = 0.001118 \times 5 \times 30 \times 60 = 10.06$ grams.

Since the values of electrochemical equivalents expressed in grams per coulomb involve such small units of time, they can be converted into units of more practical value by changing from ampere-seconds (coulombs) to ampere-hours simply by dividing by 3,600 the number of seconds in one hour. This gives 26.8 ampere-hours as the quantity of electricity required to plate equivalent weights of metals.

The values in Column 6 of Table V are therefore 3,600 times as great as those in Column 5 and formula $w = kIt$ would use for **k** the values in Column 6 and for **t** the plating time in hours. Thus, Example 1 could be solved as follows: $w = 4.025 \times 5 \times 0.5 = 10.06$ grams silver.

It is now time to point out that the constants given in Table V are based on 100 per cent current efficiency of the plating solution. The fact that the weight of metal deposited does not always equal the amount called for by calculation is no reflection on the accuracy of Faraday's laws for they have been proven by many scientists since Faraday's time to be strictly true.

The ratio of the weight of metal actually plated by a given quantity of electricity to the weight theoretically possible is called cathode efficiency. If, for instance, only 93.2 per cent of the theoretical weight is deposited, the cathode efficiency is 93.2 per cent. Assuming that exactly a faraday of electricity (96,500 coulombs or 26.8 ampere hours) had been passed through the plating solution, then $0.932 \times 96{,}500$ or 90,000 coulombs were used in plating metal; the other 6,500 coulombs probably released at the cathode an equivalent weight of hydrogen equal to $0.0000104 \times 6{,}500$ or 0.0676 gram.

While the current is depositing metal at the cathode, it is also releasing metal from the anode, thus replenishing the plating solution. The ratio of the weight of anode dissolved to the weight required by Faraday's law is called anode efficiency.

If the metal content of the solution in the example above remained constant during the plating time, the anode efficiency must have been equal to the cathode efficiency, 93.2 per cent, and the other 6.8 per cent was probably used in releasing at the anode an equivalent weight of oxygen equal to $0.000083 \times 6{,}500$ or 0.54 gram.

It is obvious that these formulas can also be used to determine cathode efficiencies of plating solutions. Platers in modern plants have access to chemi-

in acrobatics it's balance

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cal balances and to electric meters suitable for determining cathode efficiency accurately enough for all practical purposes. All that is necessary is to weigh a part before and after plating it and to record the current and plating time.

Example 2: A part weighing 15.275 grams was plated with nickel for 20 minutes with a current of 15 amperes. After plating, it weighed 20.475 grams. What is the cathode efficiency?

Solution: Total electricity used, 15 $\times \frac{20}{60} = 5$ ampere-hours.

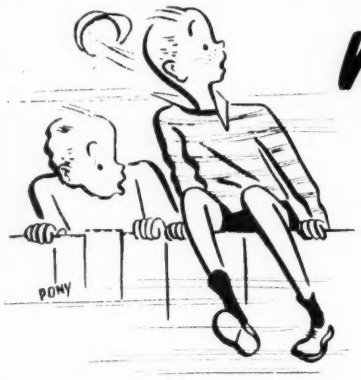
From Column 6 we have k = 1.095. Then, 5 x 1.095 = 5.475 grams nickel theoretical weight; 20.475 — 15.275 = 5.20 grams actually plated; $\frac{5.20}{5.475} =$ 0.95 or 95 per cent cathode efficiency.

Suppose it is desired to know approximately the average thickness of plate on the part in Example 2. Assume that the area of the surface of the part is 55 square inches. Then, the weight of plate is $\frac{5.20}{55}$ or 0.09454 gram per square inch. Referring to Column 8 in Table V, 0.1459 gram nickel per square inch of surface represents 0.001-inch coat of nickel.

Therefore, $\frac{0.09454}{0.1459} \times 0.001$ inch = 0.00065 inch average thickness.

Example 3: How long will it take to plate 0.00001 inch of gold on pieces having a total surface of 60 square inches if plated at a current density of 5 amperes per square foot?

Solution: Column 9 of Table V gives



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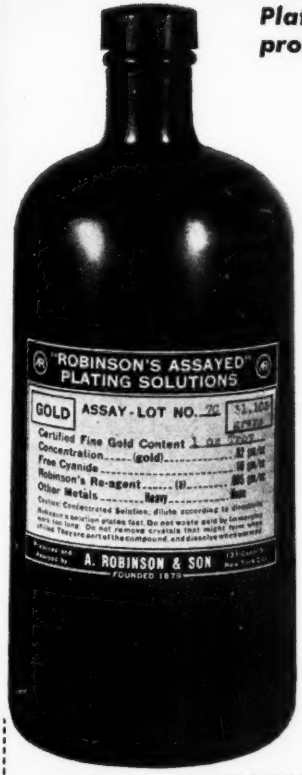

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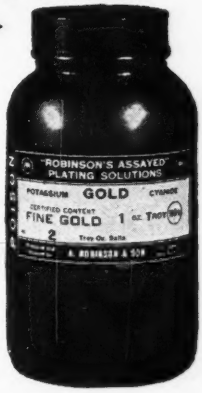

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0.0431 ampere-hour for 0.001 inch of plate per square inch. Then, 60 x 0.0431 = 2.586 ampere-hours for 0.001 inch or 0.02586 ampere-hour for 0.00001 inch; $\frac{60}{144} \times 5 = 2.1$ amperes current required at 5 amperes per square foot; $\frac{0.02586}{2.1} = 0.75$ minute or 45 seconds plating time. This would be about the proper time since the cathode efficiency of a gold solution is 100 per cent.

Example 4: How long will it take to put a plate of chromium 0.003 inch thick on the bearings of 30 shafts if the surface to be plated on each is 1 inch in diameter x 2 inches long? Use a current density of 1,000 amperes per square foot and assume a cathode efficiency of 13 per cent.

Solution: 30 x 3.1416 x 2 = 188.5 square inch total plating surface; 188.5 x 0.3572 x 3 = 202 ampere-hours (see Colum 9); $\frac{100}{13} \times 202 = 1{,}554$ ampere-hours required at 13 per cent efficiency; $\frac{188.5}{144} \times 1{,}000 = 1{,}300$ amperes plating current; $\frac{1554}{1300} = 1.2$ hours or 1 hour and 12 minutes to plate 0.006 inch on the diameter.

It is one thing to take values from tables, but it is more important that the plater be able to take basic facts and calculate the constants for himself. This final problem is offered for practice in applying the principles brought out in this article.

Example 5: How long will it take to apply a plate of nickel 0.001 inch thick to parts having a total area of 80 square inches using a current density of 40 amperes per square foot and a solution having a cathode efficiency of 95 per cent?

Solution	(From Table V)
Atomic weight of nickel	58.69
Specific gravity of nickel	8.9
Valence of nickel	2.0

$\frac{58.69}{2} = 29.35$ equivalent weight in grams (Column 4).

1 cubic centimeter nickel weighs 8.9 grams (Column 7).

1 cubic inch nickel weighs 16.39 x 8.9 = 145.87 grams.

(0.001-inch plate, 1 square inch area)

0.001 cubic inch nickel weighs 0.1459 gram) (see Column 8).

80 x 0.1459 = 11.67 grams weight of 80 square inches of nickel, 0.001 inch thick.

$\frac{11.67}{29.35} \times 26.8 = 10.66$ ampere-hours required.

$\frac{80}{144} \times 40 = 22.2$ amperes plating current at 40 amperes per square foot.

$\frac{10.66}{22.2} = 0.48$ hour required at 100 per cent efficiency.

$\frac{100}{95} \times 0.48 = 0.51$ hour at 95 per cent efficiency.

The solution, using constants from Table V, is, of course, much shorter, as follows: 80 x 0.1333 = 10.66 ampere-hours (Column 9) $\frac{80}{144} \times 40 = 22.2$ amperes plating current $\frac{10.66}{22.2 \times 0.95} = 0.51$ hour or 31 minutes.

The next article in the series will deal with the electrical principles underlying the processes of electrodeposition.

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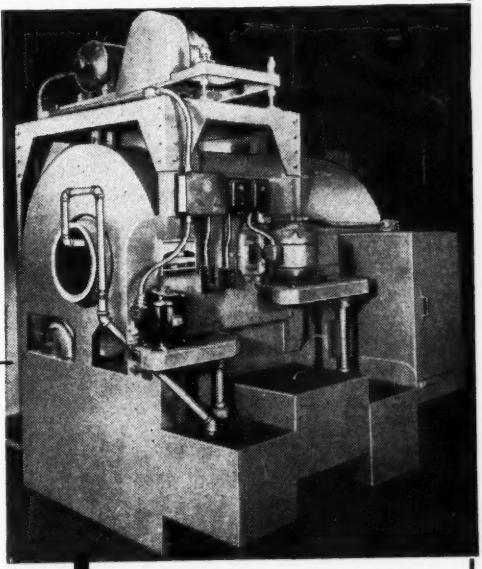

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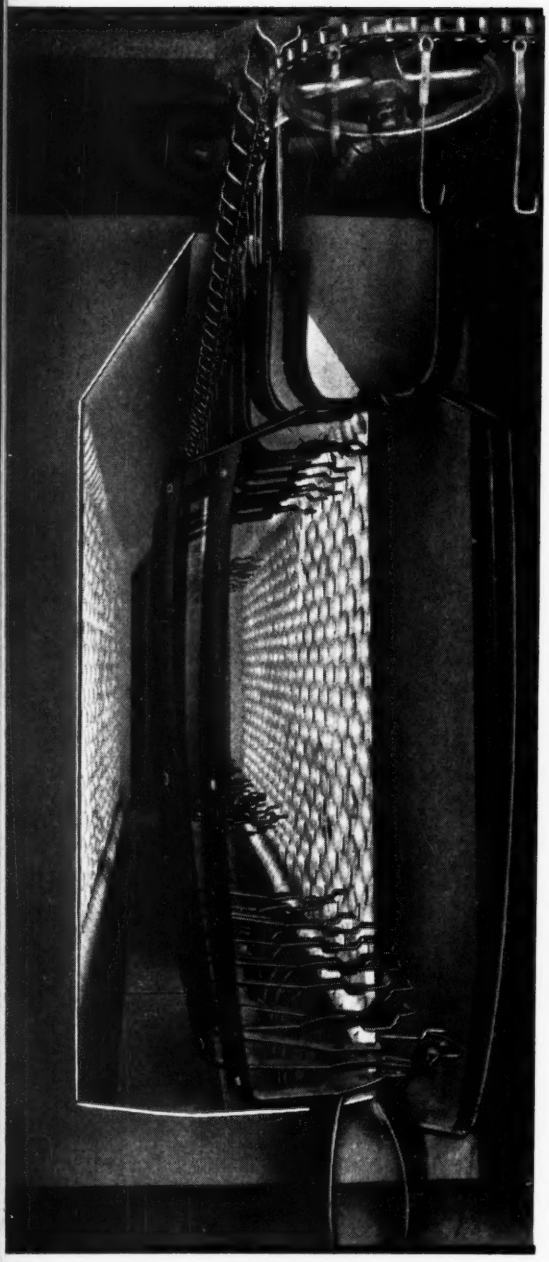


Infra-Red Speeds Bumper Production on New Automobiles

BUMPER frames for new Chrysler and Dodge cars are being finished with black baked out paint at the rate of 300 per hour in the Columbus, Ohio, plant of the Clark Grave Vault Company. This high rate of production takes on a special significance when it is revealed that the volume is achieved by an infra-red oven only 21 feet long.

This installation, made by Electric Power Equipment of Columbus with equipment designed and built by Jensen Specialties, Inc., of Detroit, had two purposes; namely, (1) to accomplish speed as well as quality in finishing, and (2) to save space. The first objective was attained by incorporating into the oven three special features which not only provided for unusual heat densities but also direct penetration of the infra-red rays to the painted surface. The second ob-

Bumper frames enter the infra-red oven where they are finished with black baked out paint at the rate of 300 per hour.

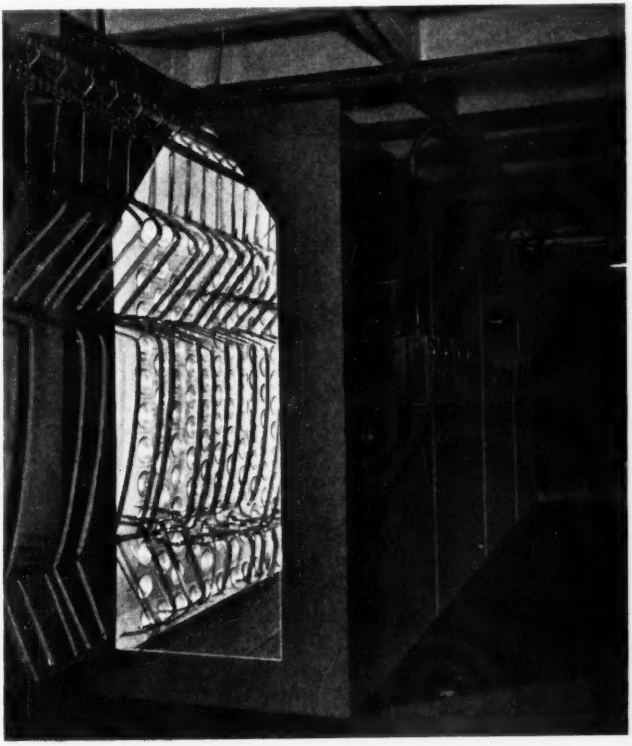
jective, space saving, was made possible due to the fact that the finishing was so efficient that the 300-per-hour-rate could be achieved in an oven limited to only 21 feet in length.

In finishing operations of this type, one troublesome problem to be overcome is "fog," resulting from dissipated solvents, interfering with the desired penetration of the radiant energy rays. In designing the oven, Jensen incorporated a system of downdraft ventilation for free and easy circulation. This provision resulted in a constant circulation of fresh air. Actually, the air within the oven was never at any time recirculated. This feature, together with a blower system, fulfilled the need for constant and continuous elimination of the dissipated solvents and achieved the aim of direct penetration of the radiant energy rays to the painted surfaces of the bumper frames.

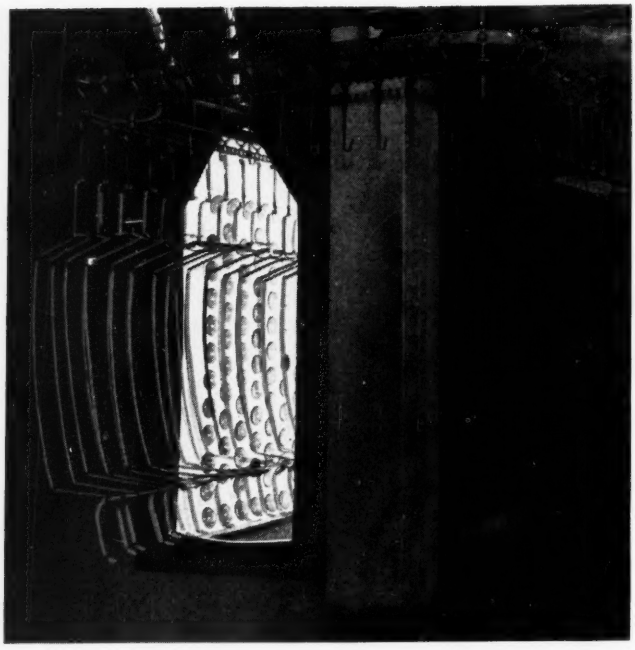
The oven was engineered with the "dual heat" principle, a method which combines radiant energy heat with convection heat. Being doubly-enclosed, the oven retained all the heat generated through radiation and thus provided a maximum amount of heat in a minimum length of time.

Still another feature of design which resulted in unusually fast finishing was the unique method of lamp arrangement. The oven contains 864 lamps which are "staggered" in an "overlap" arrangement, very much as bricks are layed. This "stagger" or "nesting" arrangement had the desired effect of appreciably stepping up heat densities.

These three features—elimination of "fog," incorporation of "dual heat," and arrangement of lamps on a "nested" setup—combined to make possible the high finishing rate of 300 bumper frames per hour in an oven only 21 feet long. The conveyor installed to



This view of the infrared oven used at Clark Grave Vault Company to finish bumper frames shows how the lamps are "staggered" in a "nesting" arrangement to step up heat densities, also the limited size of the oven.



Bumper frames are shown being conveyed into the infra-red oven by a Jensen loop-around conveyor.

heat carry the bumper frames through the oven is a Jensen-built loop around conveyor.

Sanding and Finishing Tool. A four-page folder illustrating and describing the performance and application of a brush-backed sanding head for contour finishing, known as the "Sand-O-Flex," is now being distributed by the Sand-O-Flex Corp., 4373 Melrose Avenue, Los Angeles 27, Calif. Copy free upon request.

"Liquid Envelope" Peelable Plastic Film, product of Better Finishes & Coatings, Inc., 268 Doremus Ave., Newark 5, N. J., is covered as to present and potential applications in the metal-working industries in a 12-page booklet published by this firm. Illustrated and described is the use of Liquid Envelope in protecting sheets, parts, and tools in transit or in stock; as a masking material during final assembly or finishing, and so on. Copy free upon request.

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Buckeye "Speedie" Polishing and Buffing Compositions. A complete line of polishing and buffing compositions for a wide variety of requirements is presented in a 16-page illustrated booklet prepared by The Buckeye Products Co., 723 Vine St., Cincinnati, Ohio. Made from high quality greases and abrasives, the compositions, which are known as "Speedie," are described as available in the following types: stainless steel composition; chrome rouge (white); bright gloss chrome finish; bright gloss; white finish; tripoli composition; tripoli copper buffing composition; cut and color composition; white coloring composition; emery cake; grease stick; and abrasive grease stick. Copy of booklet free.

Foxboro Instrument Catalog 370. The Foxboro Co., Foxboro, Mass., has issued a catalog presenting the company's full line of recording and indicating instruments for measurement and control. Arranged for quick reference and profusely illustrated, the catalog includes sections dealing with instruments for temperature applications, pressure, humidity, flow, liquid level, density, and other process variables. Control valves, plainmeters, instrument accessories, and supplies are covered.

A feature of the catalog is a section on the line of Dynalog electronic instruments now being offered for civilian use by the company. Copy of Catalog 370 free upon request.

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Finishing Clinic

By DR. ALLEN G. GRAY

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A Monthly Digest on Current Technical Progress Indicating Significant Trends and Developments in the Finishing Industry

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THIS MONTH . . . Choosing a Finish for Magnesium . . . The Role of Nickel Flashing in Enamel Adherence . . . Electrolytic Analysis of Strike Solutions Suitable for Production Use . . . Fungicide Coatings . . . Black Anodizing Copper and Brass . . . Proper Pretreatment of Metals Essential for Quality Finish.

Choosing a Finish for Magnesium

IT is well for the finishing engineer to keep in mind the fact that most acceptable finishes for magnesium alloys comprise a combination of a chemical surface treatment plus an efficient and carefully compounded organic finish system. So far as chemical treatment is concerned, most magnesium products are dichromated by the producer prior to shipment. Thus, if parts are used as received, often no additional chemical treatment will be required. If, however, additional manufacturing operations injure or remove a portion of the chemically treated surface, it will be necessary to re-treat before any organic finish is applied.

Most organic finishing systems for magnesium will involve the use of either two or three different finishing materials, each applied in single or multiple coats. Prime coats and top coats are a requisite, and, in certain instances when a high finish luster is desirable, a filler coat is applied between the primer and finishing coats. Each of the materials selected must exhibit certain qualities that are compatible with each other, with the magnesium alloy involved, and with the service conditions of the particular product.

In all organic finishing systems, the primer coat is generally the first material applied. The careful selection of a primer is important in view of the fact that it must not only exhibit anti-corrosive and preservation qualities, but must serve as a bond or anchor between all subsequent coats and the magnesium alloy. Generally, the basic pigments have proved most satisfactory for use with magnesium. Most finishing men consider zinc chromate to exhibit

the best all around characteristics. The use of red oxide as a primer pigment has met with good results but requires baking to bring out the optimum qualities.

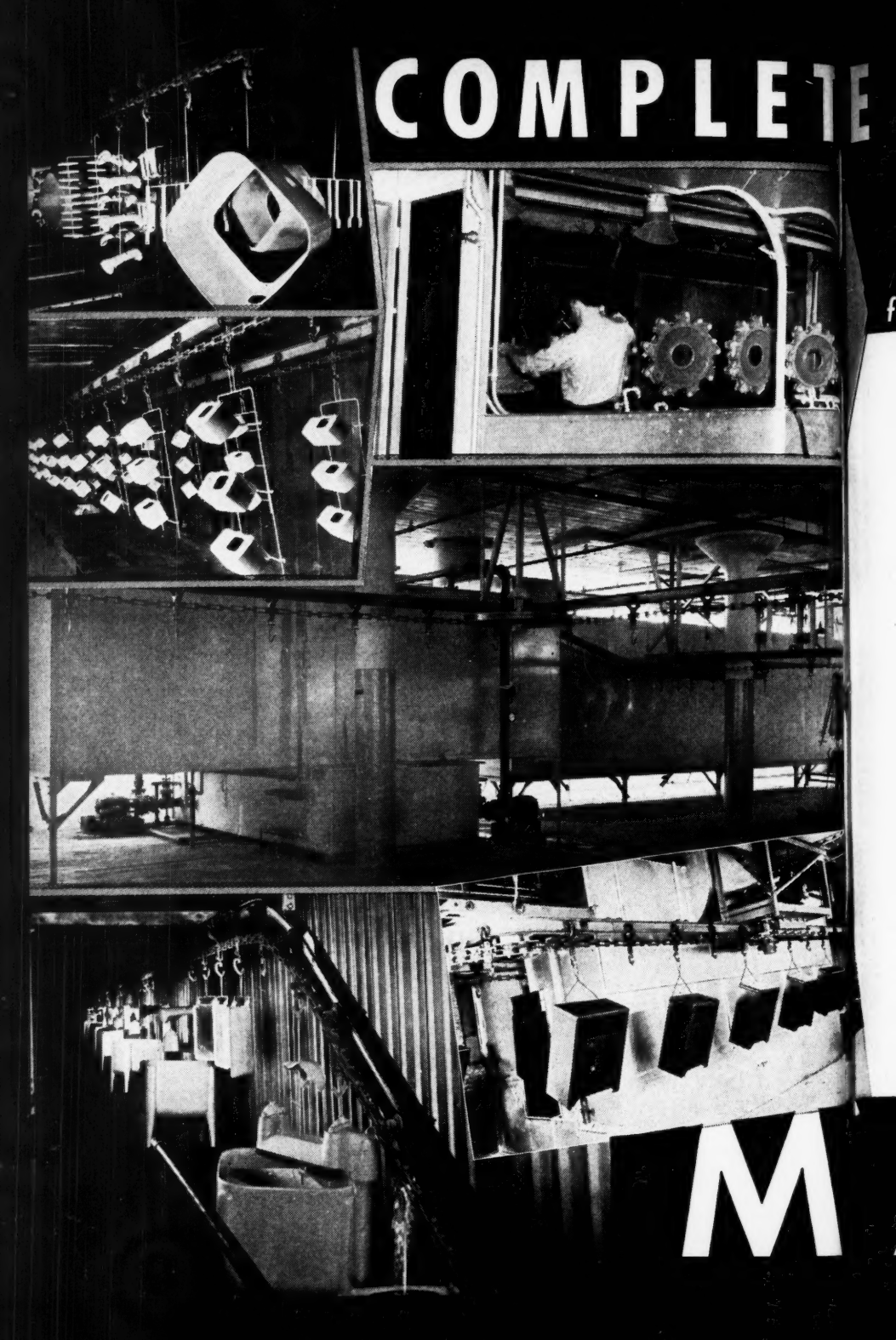
In selecting a vehicle for the pigment, a fairly wide choice of materials is available. Thus, the selection is often modified to meet specific manufacturing or service conditions. Oxidizing oils, such as linseed oil, will give good service as primer vehicles, however, in either the boiled or raw form, they are regarded as being slow to dry. This is a disadvantage from the production man's standpoint as it necessarily slows the flow of products through the finishing department. The phenolic resin varnishes and tung oil are comparable to linseed oil in the length of time required to dry. A combination of the alkyd resins with phenolic resins results in a product with very good primer vehicle qualities. This combination shows resistance to moisture penetration, good adhesion, flexibility, toughness, and is fairly fast drying. The nitrocellulose lacquers as primer vehicles are fast drying but tend toward brittleness with a resultant loss in adhesion.

The large number of present day synthetic resins available, along with the hard resins and various plasticizers, offer wide possibility in blending a primer vehicle to meet practically any condition. It is important that any grease, oil, or dust be removed from the chemically treated magnesium part before primer application. The air in the paint shop should not be excessively humid and the temperature should be in the range of 70 deg. F. Care should be exercised to assure even distribution of the primer over the entire surface. The surface tension of the liquid may tend to draw the coating thin over such areas as sharp radii or angular projections, thus creating the possibility that a small area of the base metal may be left in the unprimed state.

When it is necessary to produce a very high quality finish, it may be desirable to employ a surfacer or filler coat between the prime and finish coats. Sanding of the surfacer before application of the finish coat will produce a high gloss finish. However, it should be remembered that the filler coat cannot be considered a substitute for any of the coats required in the protective system.

As is the case with the finishing of any particular article, the greatest factor bearing upon the selection of a finish coating material will be the subsequent use of the product. For exterior exposures free from unusual cor-

Chrome pickling operation being performed on a magnesium sand casting
(Photo Courtesy The Dow Chemical Company)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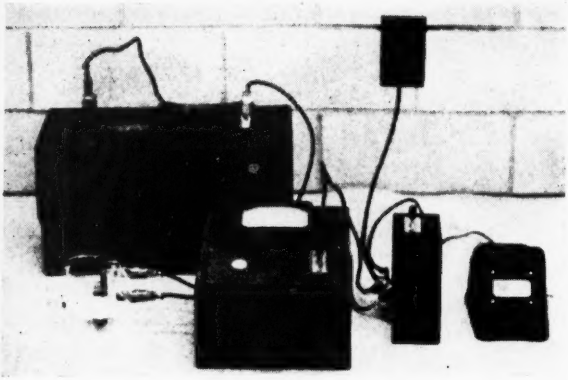


Complete apparatus for making an electrolytic analysis

rosive conditions, the oil-base synthetic resin enamels of the glycerol phthalate or phenolic types will provide satisfactory results.

Indications are that baked finishes are very effective for the protection of magnesium. Since many finishes do not require baking at temperatures in excess of 270 to 300 deg. F., generally no effects on the metallurgical properties of the alloy will be experienced under these conditions. The best finishes for baking are the oil-base phenolic resin varnishes or enamels pigmented with aluminum paste. Certain plastic coatings of the urea type have also been used with good results.

The number of prime and finish coats required will depend largely on conditions to be encountered by the product. One coat of primer followed by one or two coats of finish is generally considered the minimum for indoor exposures. Under outdoor conditions and conditions of extreme corrosion, one coat of primer and two or three coats of finish should be employed. Also, in certain cases, it may be advisable to use multiple coats of primer. When corrosive conditions are anticipated during the service life of magnesium products, the finishing engineer will find that care in the selection and application of finishing materials will pay large dividends in quality performance.

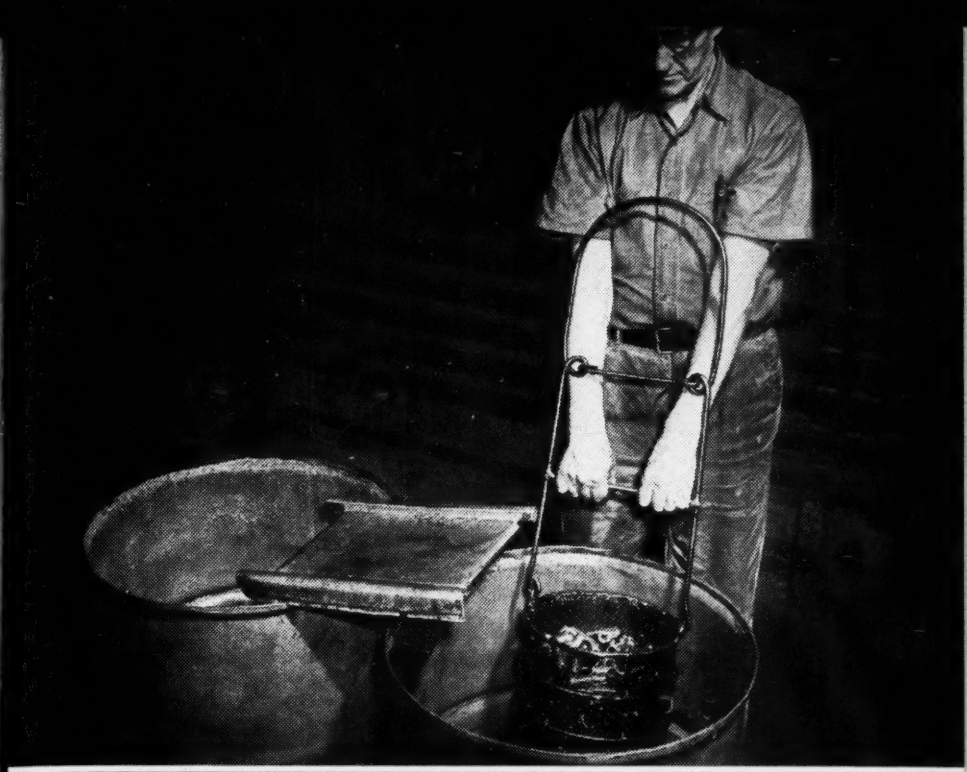
* * *

The Role of Nickel Flashing in Enamel Adherence

OF interest to metal finishers dealing with porcelain enamels is a recent report by E. Wainer and W. J. Baldwin (American Ceramic Society, April Meeting) on studies that have been made of the effects of nickel flashing of enameling stock upon enamel adherence. It has been shown that the role of nickel in developing adherence is apparently bound up with the retardation of oxidation of the iron base.

Adherence may be considered as a corrosion problem of the base iron, developed by the action of gases, especially oxygen, and other corrosion agents that may be present at the enameling temperature. The equilibria between the gases and solids are strongly affected by the nickel. The results appeared to indicate that adherence is a function of the oxygen concentration at enameling temperatures, assuming the ability of the enamel to dissolve or react with the product of the oxidation.

Experimental evidence indicates that ferrous oxide, FeO, is the important one for adherence, and that the nickel flash, by restricting the oxidation of the iron base, tends to ensure the formation and stabilization of ferrous oxide. When adherence develops, both nickel and iron are oxidized to NiO and FeO respectively at the temperatures of the enameling process. If



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higher oxides are formed before the glass fuses, adherence is lost.

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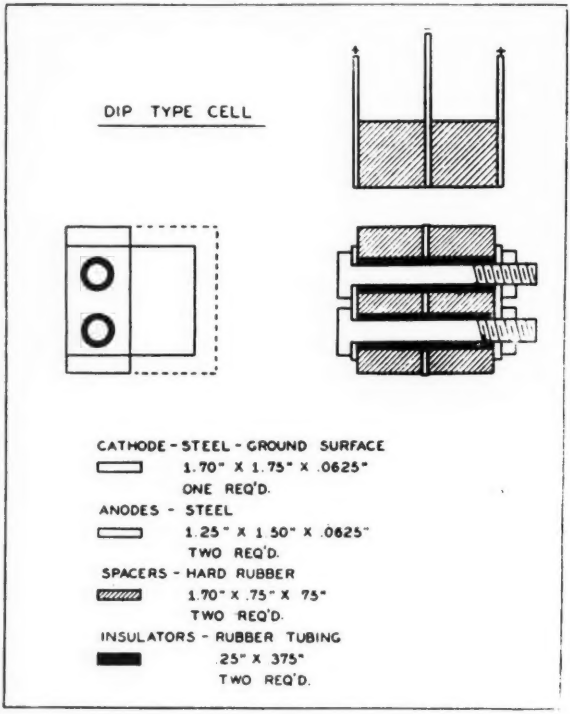
Electrolytic Analysis of Strike Solutions Suitable for Production Use

ALL production men dealing with electroplated finishes will agree that the proper application of a metal strike in the electroplating process is an important step in obtaining a good adhesion between the base metal and the electroplate, thus contributing materially to the acceptability of the entire finish. The strike is usually operated at low cathode efficiency so that the copious evolution of hydrogen will surface-clean the work prior to plating. Since this is one of the principal functions of a metal strike, analysis and control of this property of the strike solution becomes an important factor in production plating. In general, the standard methods of coulometer control of cathode efficiency are not adaptable for simple strike solution control. The cathode efficiency of the strike bath depends very much upon temperature, current density, and bath composition.

A rapid method of determining the approximate cathode current efficiency of silver and copper strike baths employing a new electrolytic cell was described by R. A. Schaffer and J. B. Mohler at the regular fall meeting of the Electrodeposition Division of the Electrochemical Society, held in New York City in October, 1945. The method is based on the fact that the amount of metal deposited on a test specimen from a strike solution is proportional to the time at constant temperature and constant current density. This quantity of metal may be determined by measuring the deplating time, where a sudden drop in current marks the end point, which is in many respects analogous to everyday production use of electrolytic thickness measurements.

The **apparatus** used consists of a dip-type cell constructed similar to a conductance cell except that three electrodes were used instead of the conventional two electrodes. The most



Cross-section and plan view of a dip-type cell

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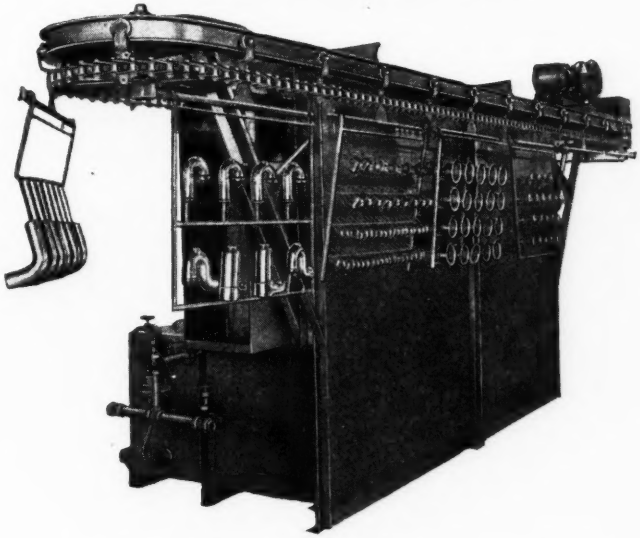

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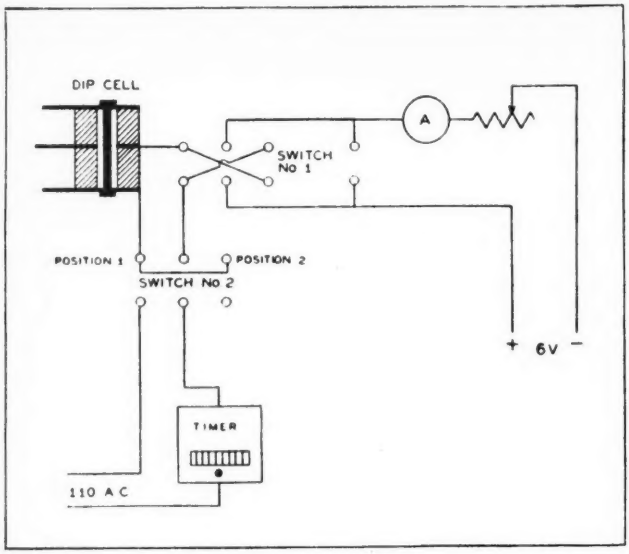

Diagram of an electric circuit

satisfactory material found for electrode construction was S.A.E. 1010 cold-rolled steel. The instrument box used contained a rheostat, an ammeter, a reversing switch, and a short circuiting switch. Adequate insulation of wires leading to the electrodes of the dip cell was found to be a very important item since any current leaks in this high current density area will produce an error.

In the experimental procedure for carrying out the analysis of a **silver strike** solution, the center electrode is first made anodic to remove any silver films from either a prior run or immersion plate, following which the rheostat is set for exactly one ampere. Next, switch No. 1 is closed (see diagram), making the center electrode cathodic, and plating is carried out for exactly one minute at exactly one ampere. Following this, switch No. 1 is short circuited, and the rheostat set so that 0.10 amphere will flow on deplating. Thus, the center electrode is anodic and the deplating time is measured. At the end of this time, the deplating current in the circuit suddenly drops from 0.100 amperes to 0.08 ampere, at which point the silver will be all deplated and the anode polarization will increase rapidly. Shown in Fig. I is a plot of the silver cyanide content of the bath **vs.** the deplating time in minutes. The deplating time varies in direct proportion to the silver cyanide content of the bath.

The experimental procedure used for the analysis of **copper cyanide** solutions was similar to that for the corresponding silver solutions except that a plating time of one-half minute and a plating rate of one-half ampere were used. The deplating rate was 0.20 ampere, with 0.18 ampere used to mark the end point. The testing of copper cyanide solutions is somewhat more complex than the testing of silver solutions because the rate of copper deposition varies appreciably with the free cyanide content of the bath. Figure II shows the effect of copper and free cyanide on the cathode efficiency.

An extensive study was made of the application of this method for the control of silver and copper strike solutions under conditions of plating shop practice. Of the many factors investigated, none was found to influence the

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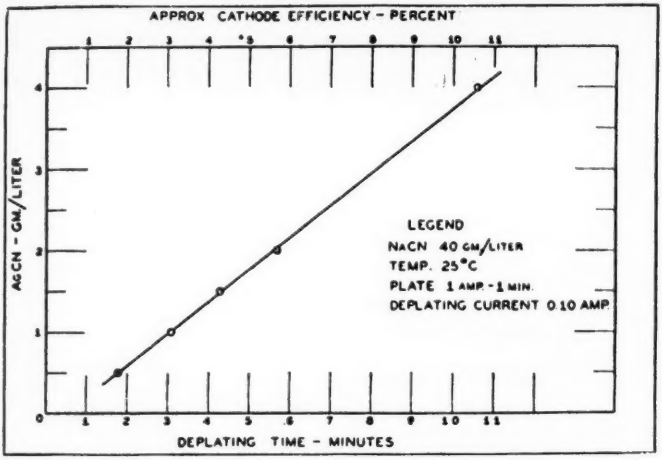

Fig. I—Variation of cathode efficiency with metal concentration

accuracy of the results, except that collodial materials in the bath must be avoided, since these were found to have a pronounced effect on the deplating time. Production men will find this new tool valuable for the control of strike solutions in plating shop practice.

* * *

Fungicide Coatings

WRITING in the May 1945 issue of "Industrial Finishing," Fred Simmons has pointed out that certain components of radio, radar, and automotive equipment, and so on, when exposed to the steaming hot swampy jungle atmosphere of the Pacific, have been destroyed by fungus attack in as short a time as 72 hours. The application of fungus-resistant lacquers and varnishes, while not a complete cure, provides for a considerable improvement in the life of articles exposed to these conditions.

Fungicidal varnishes, while toxic and not to be taken internally, are not dangerous to apply if the workroom ventilation is adequate. Two types of materials are commonly used. The first is a bakelite resin varnish containing pentachlorophenol as the active ingredient. It is generally considered to be the most widely applicable type and is harmless to most radio components. The second is a lacquer-base material containing phenyl mercuric salicylate as the active ingredient. The latter material is more flexible and generally considered ideal for application to rubber insulated wire and cable, but is harmful to certain radio components.

Certain special problems are usually involved in the application of these materials. Often, parts are most conveniently treated before final assembly or in sub-assemblies. Each application presents its own problems which will require careful study before proceeding with the production application of this type of finish.

* * *

Black Anodizing Copper and Brass

A method for blacking copper or brass by anodizing in an alkali solution has been described ("Metal Finishing," June, 1945). The solution used contains 16 oz./gal. of sodium hydroxide and has a density of 12 deg. Baume. It is operated at 180 to 212 deg. F. Steel, carbon, or graphite cathodes are used. Plain steel tanks are satisfactory, and adequate ventilation is required. A line voltage of 6 volts is generally sufficient, and, during oper-

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ation, the voltage is increased stepwise as anodizing proceeds. The cycle followed is: 45 seconds at 2 amp./sq. ft., 90 seconds at 4 amp./sq. ft., 135 seconds at 6 amp./sq. ft., 180 seconds at 8 amp./sq. ft., and 225 seconds at 10 amp./sq. ft. The time and current density after 10 amp./sq. ft. is reached are not critical.

The work can be cleaned in the usual manner before blackening, or the blackening bath can be used for cleaning. The sodium hydroxide content of the bath is maintained by hydrometer readings or by titration. Care must be taken in rinsing after blackening, as the caustic film has a tendency to adhere. Successive hot, cold, and hot rinses are effective. On removal of the work from the tank, the appearance of the black finish is velvety. On wiping with a cloth, a smooth adherent black is produced which may be polished if desired. Lacquering produces a glossy jet black finish, but is not necessary. Metal-finishing production engineers interested in a black finish on copper or copper alloys containing over 50 per cent copper will find an investigation of this process worthwhile.

* * *

Proper Pretreatment of Metals Essential for Quality Finish

TO manufacturers of many metal products, maintaining a fine appearance will become a vital problem, particularly in peacetime competitive merchandizing. Paint, enamel, and lacquer are generally considered inadequate in themselves as a finish for articles that will be subjected to severe exposure because of the inherent tendency of the underlying metal to corrode, causing premature paint failure such as chipping and peeling. In general, the difficulty of maintaining paint and lacquer finishes is due to three main causes: (1) corrosion of the underlying metal, (2) lack of adhesion of the paint or lacquer film to the metal, and (3) durability of the paint film itself. To overcome some of these difficulties, the pretreatment of metals by such treatments as phosphating for increased paint and lacquer durability has come into widespread use in the finishing industry.

In this period of reconversion, metal finishers should investigate the advances that have been made in rust-

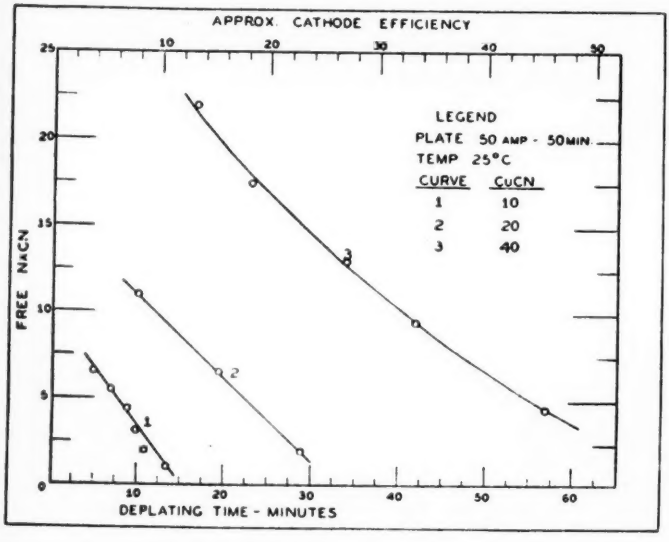
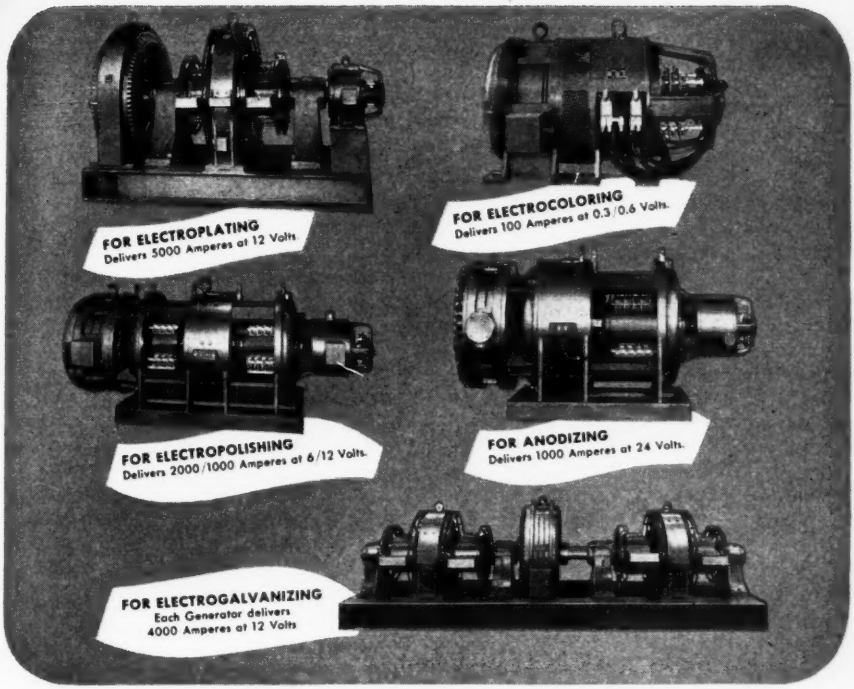


Fig. II—Effect of copper and free cyanide on cathode efficiency (NaCN and CuCN conc. in g./l.)



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proofing processes in the past few years so that finishing systems can be best adapted to meet the demands of new products. Research has shown that the application of an organic finish directly over bare metal is an inferior solution for the corrosion problem. Most finishing engineers are fully aware of the fact that the resistance of most metals to corrosion is due to the formation of relatively insoluble corrosion products on the surface by reaction with non-metallic elements of the surroundings. By the proper choice of solutions and conditions, it is possible to produce coatings of this type on almost any metal. The principal function of rustproofing processes is to transform the metal surface into a non-metallic chemical coating that offers some resistance to corrosion, while at the same time providing an improved bonding surface for subsequent paint coats. The non-metallic coating formed by the rustproofing solution is not a chemical deposit on the surface of the metal, but is an inherent part of the metal itself. Proper investigation may reveal many recent improvements, both in process efficiency and methods of applications, to the metal finisher who has not used such a process in the past few years.

Most chemical rustproofing processes are economical, easy to apply, and require a minimum of additional shop equipment. In general, they do not alter the dimensions of the part in any way, and, although such treatments are usually followed by painting, lacquering, oiling or waxing, they are sometimes used on mechanically moving parts that are not painted. Metal finishers should investigate chemical pretreatments of metal products to an extent sufficient to ensure optimum performance in durability and life of the finishes applied.

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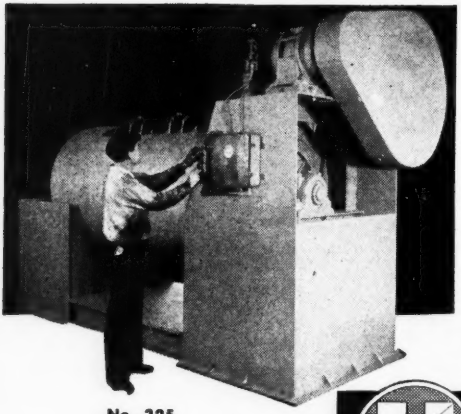

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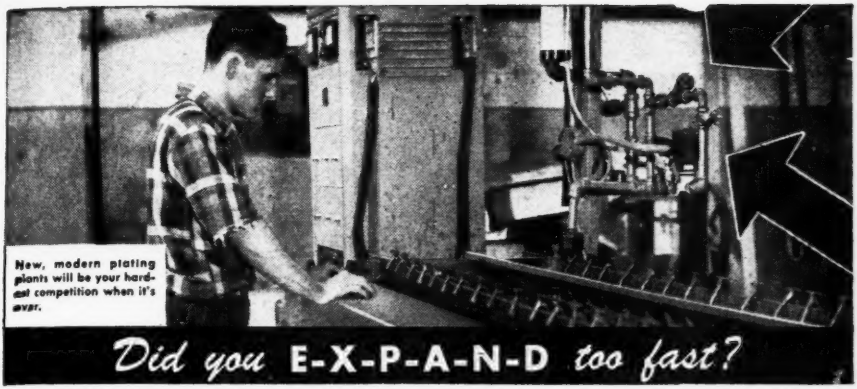

The contribution of the plating industry to the war effort will never be completely told. Production was doubled and trebled overnight—without time to engineer the job for efficiency, and with many needed accessories not available.

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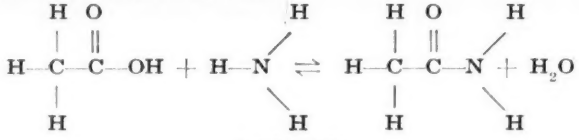
Organic Chemistry

By C. B. F. Young, Ph.D.

Part 7

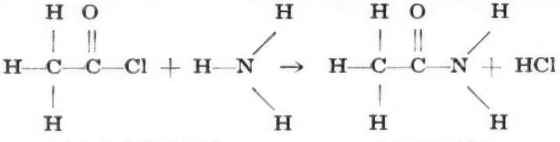
IF acetic acid is allowed to react with ammonia an amide is formed. The reaction below illustrates this.



Acetamide

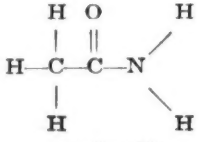
It will be noted that there are two arrows each pointing a different way. This is to show that equilibrium is obtained; that is, a balance is obtained between the left and right. The reaction does not go to completion.

On examining the above, it will be seen that the OH group in —COH has been replaced by a NH_2 group. These materials can be prepared by allowing ammonia and an acid chloride to react together as shown below.



Acetyl Chloride Acetamide

There are primary, secondary, and tertiary amides as shown by the formulas below.



Acetamide

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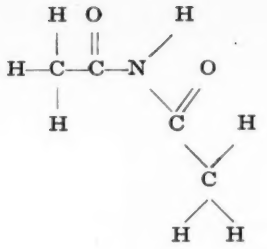
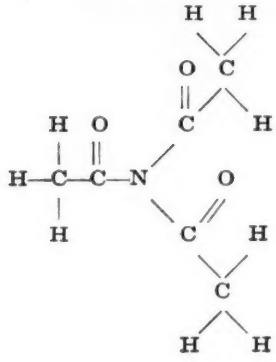
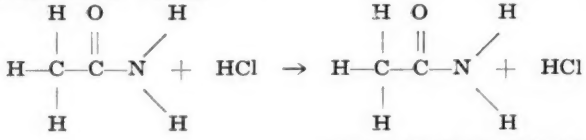


Diacetamide

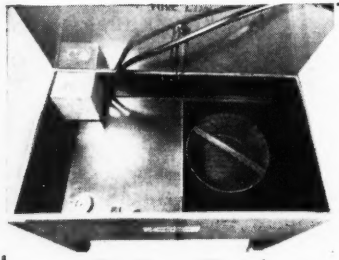


Triacetamide

The only important amides are the mono derivatives. Amides can react with bases and acids. Thus:



Acetamide Hydrochloride



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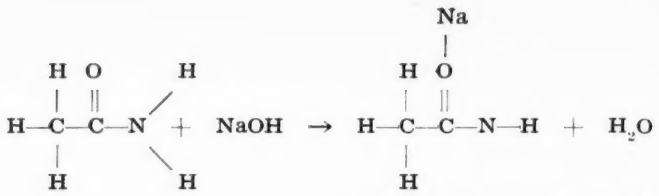
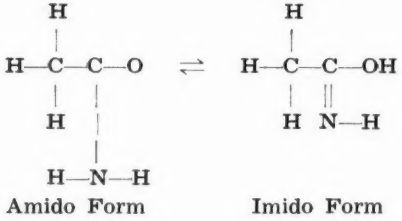
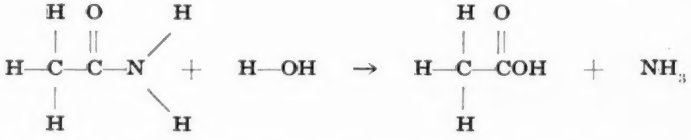


From the above reactions, it can be seen that an imide can exist in two forms. The material can contain an acid H atom. This is explained by the equation below.

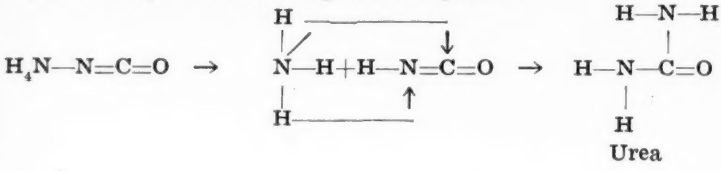


The most important reaction of the amides are their ability to hydrolyze. Thus:



Urea is the amide of carbonic acid and has the following formula.

This material is interesting from the historical point of view because in 1828 Wohler showed in his laboratory that it was possible to prepare an organic compound from inorganic materials without the aid of the life cycle. Thus, a new era in chemistry began. Wohler prepared urea by heating ammonium cyanate according to the equation:



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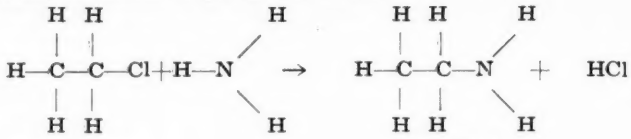
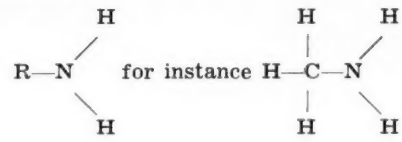
Amines

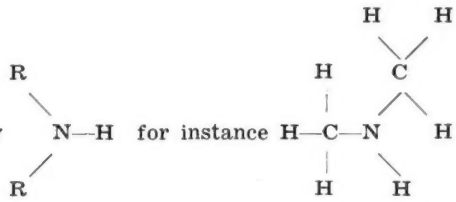
If a paraffin is chlorinated and the resulting chloride allowed to react with ammonia, an amine is produced. Thus:

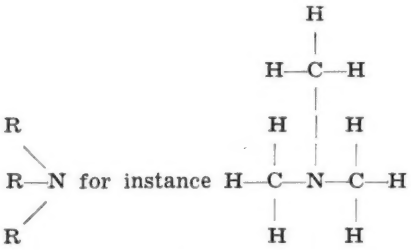


Ethyl Amine

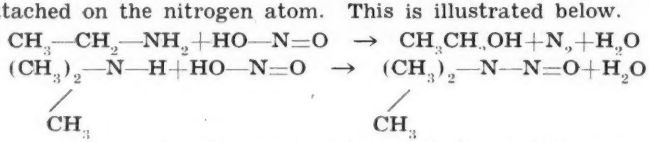
An amine is composed of a nitrogen atom which may have carbon or hydrogen attached to its bonds. As one would expect, there are primary, secondary, and tertiary amines.

1. Primary 

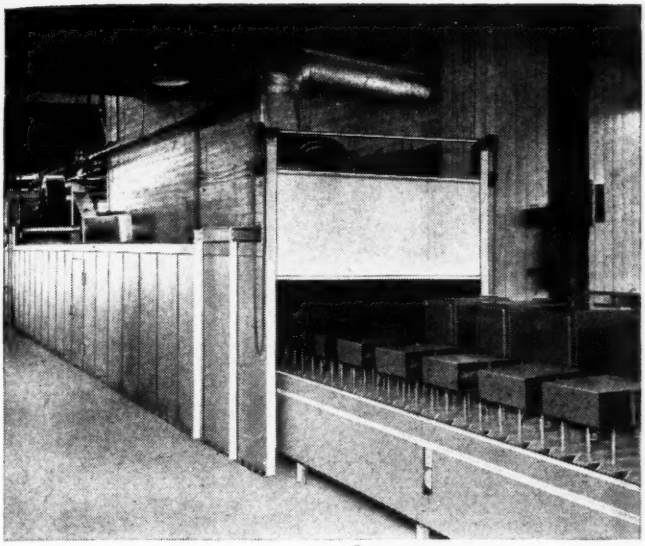
2. Secondary 

3. Tertiary 

A primary amine unites with nitrous acid to produce an alcohol, nitrogen, and water. A secondary amine unites with nitrous acid to form a nitrosamine and water, while a tertiary amine cannot react with this reagent since it has no H attached on the nitrogen atom. This is illustrated below.



Primary amines only will react with an alkaline solution of chloroform, forming thereby an isocyanide or carbylamine.



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Methyl Isocyanide or Carbylamine

It will be recalled that these materials have already been mentioned under the chapter on acids. We spoke of the amino acid group and discussed these

materials when connected to a —COH group. The NH_2 radical is known as the amino group. It should also be stressed that amines have many properties similar to ammonia. Amines, like methyl amine, have a characteristic fishy and ammoniacal odor. The material is a gas and is very soluble in water. Higher aliphatic amines, however, are liquids, generally insoluble in water and almost odorless.

It should be pointed out that water soluble amines are more basic than ammonia and can be used in a number of places to produce more OH ions than NH_4OH produces. Thus, methyl amine acts as shown below.

Many amines are available in commercial quantities at prices which are quite reasonable. Among these are the following:

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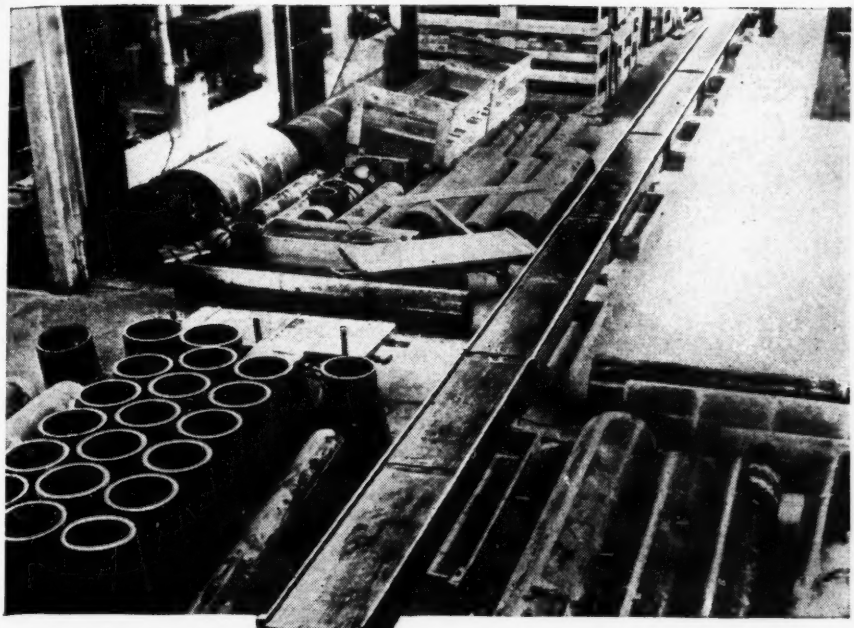

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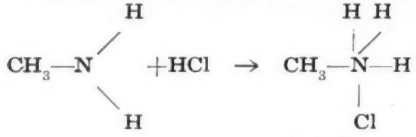
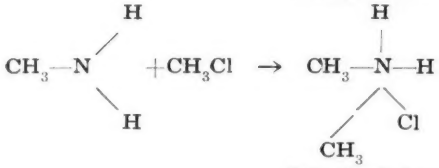
Triethanalomine	Diethylaminoethanol
Diethanalomine	Diethylene Triamine
Monoethanalomine	Triethylene Tetramine
Ethylene Diamine	Tri-isopropanolomine

In the compound CH_3NH_3OH, it will be noted that the nitrogen has a valence of five. These molecules are known as quarternary ammonium compounds if an OH ion is present. Amines will react with acids, alkyl halides, and so on, to produce pentavalent nitrogen compounds. Thus:

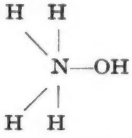


Methyl Ammonium Chloride

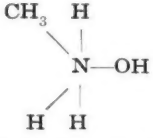


Dimethyl Ammonium Chloride

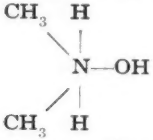
One can see that in NH_4OH there are four replaceable hydrogens. This is illustrated below.



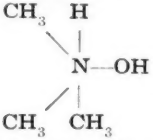
Ammonium Hydroxide



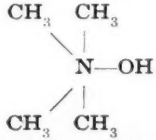
Methyl Ammonium Hydroxide



Dimethyl Ammonium Hydroxide



Trimethyl Ammonium Hydroxide



Tetramethyl Ammonium Hydroxide

The last mentioned compound is a very strong base. In fact, it is about as strong as NaOH. These materials are being used in many places today to produce results which require a high pH and a complex molecule.

Cyanides

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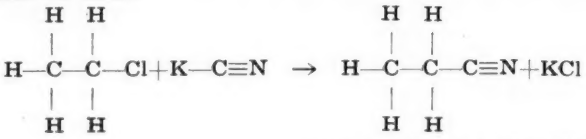
They are used in electroplating, cleaning, heat treating, and coloring. These materials are used as sodium and potassium salts. Originally both were made in Europe, especially Germany. During the first war, the U. S. was without a supply of cyanides. In terrific haste, American industry set up plants for manufacturing sodium cyanide. Before the outbreak of World War II, American industry started research and later manufacture on the potassium compound. Due to such brilliant foresight, America has had a sufficient supply of these materials.

One method of manufacturing these products is to fuse a mixture of calcium cyanamide, carbon, and sodium carbonate. Thus:

$$CaNCN + C + Na_2CO_3 \rightarrow CaCO_3 + 2NaCN$$

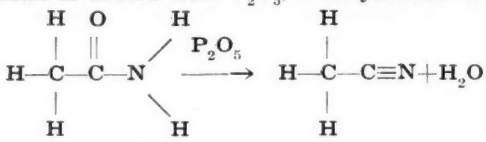
Sodium Cyanide

Organic cyanides can be made in several ways. Below the equations are given for some of these.



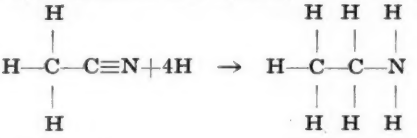
Methyl Cyanide, Methyl Nitrile, or Acetonitrile

If a simple amide is heated with P_2O_5, a dehydration takes place. Thus:

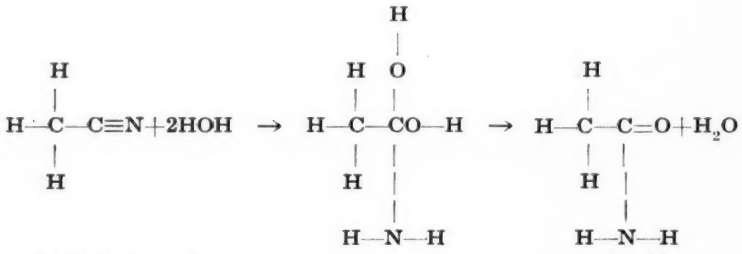


Acetamide

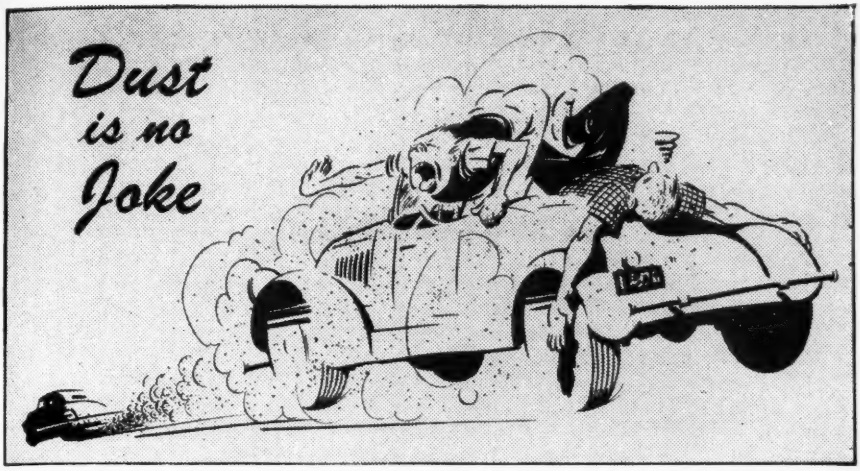
Cyanides may be hydrogenated and hydrolyzed as shown below.



Methyl Cyanide — Ethylamine



Methyl Cyanide — Acetamide



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Cyanamide

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$$CaC_2 + N_2 \rightarrow CaNCN + C$$

* * *

Organic Sulphur Compounds

Sulphur and oxygen are similar in many ways. They form many similar compounds, for instance H_2O and H_2S. In organic chemistry, this is also true. Sulphur can be substituted for oxygen in alcohols, ethers, esters, and acids. One characteristic property of the sulphur or thiocompounds is their disagreeable odors. In many instances, the odors are similar to that of garlic.

If sulphur is substituted for oxygen in alcohols, thioalcohols result. Thus, if potassium bisulphide is allowed to react with an alkyl bromide, the following results:

$$C_2H_5Br + HSH \rightarrow C_2H_5SH + KBr$$

Ethyl Thioalcohol

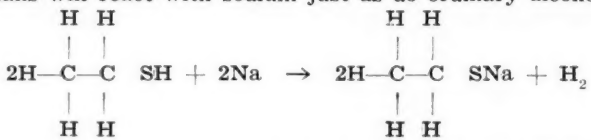
Thioalcohols are also known as mercaptans and the salts are known as mercaptides. Thioalcohols can also be formed as shown below:

$$5C_2H_5OH + P_2S_5 \rightarrow 5C_2H_5SH + P_2O_5$$

A thioalcohol will react with mercury compounds to form salts which are easily crystallized. Thus:

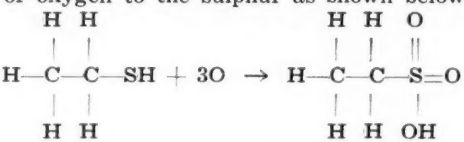
$$2C_2H_5SH + HgO \rightarrow Hg(SC_2H_5)_2 + H_2O$$

Mercaptans will react with sodium just as do ordinary alcohols. Thus:



Sodium Thioethylate or Sodium Ethyl Mercaptide

Thioalcohols react differently when oxidized than do alcohols. The former add three atoms of oxygen to the sulphur as shown below:



Ethyl Sulphonic Acid

Ethyl sulphonic acid is a strong acid.

If a thioalcohol is allowed to react with an acid, a thioester results:

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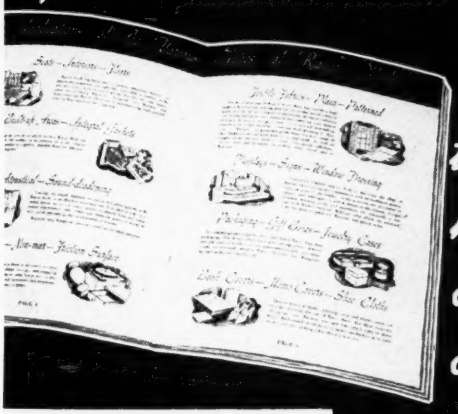

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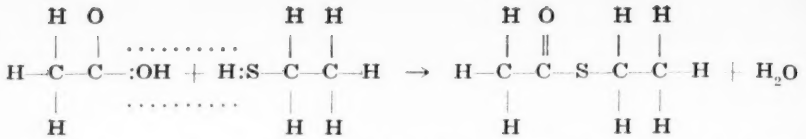
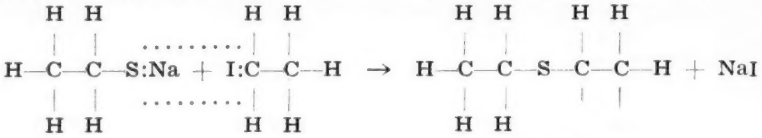


It should be pointed out here that the OH group is furnished by the acid. The H is given by the thioalcohol because H_2O results and not H_2S. This also proves that the formation of esters is not a neutralization of an acid and a base.

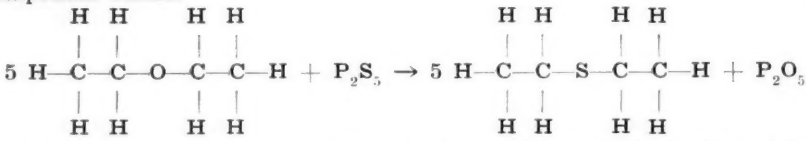
Thioethers can be formed in the same manner as ordinary ethers. Thus:



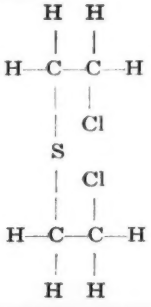
Diethyl Thioether

Diethyl Sulphide

If P_2S_5 is allowed to react on ordinary ethers, the corresponding thio-compounds result:



It is interesting to note that "mustard gas" (dichloroethyl sulphide) is a derivative of diethyl sulphide. The material is an oily liquid which vaporizes slowly, thereby maintaining a concentration in the atmosphere which is toxic. In the liquid or vapor phase, the material will produce serious skin burns. The formula is given below.



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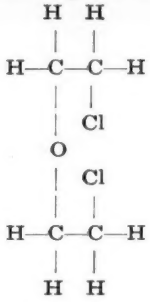
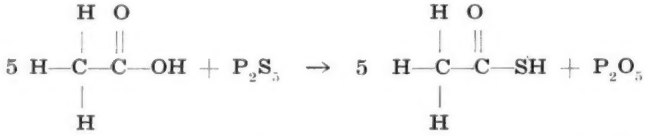
An interesting comparison can be made here. If an O is substituted for the S in the above compound, dichlorethyl ether is produced. This material is used in large quantities for a dry cleaning agent, and, of course, is comparatively non-toxic. The formula is given below.



Thioacids can be prepared from ordinary acids by treatment with P_2S_5. Thus:



The thioacids are generally stronger than the corresponding acids while their boiling points are lower.

Anhydrides of thioacids can be prepared but are not important.

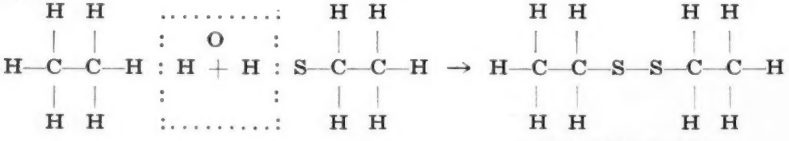
It will be noticed that no discussion has been forthcoming on thioaldehydes and ketones. These materials polymerize very readily and form larger molecules. The C=S group is much more reactive in regard to unsaturation than the C=O group.

A very important sulphur compound is carbon disulphide. It is made by uniting the two elements in an electric furnace in the absence of air. Thus:

$$C + 2S \rightarrow CS_2$$

Carbon disulphide is a solvent and can be used as a starting point for manufacturing carbon tetrachloride.

There is a series of sulphur compounds known as disulphides. They can be made by oxidation of the thiocompounds. This can be illustrated as shown below:

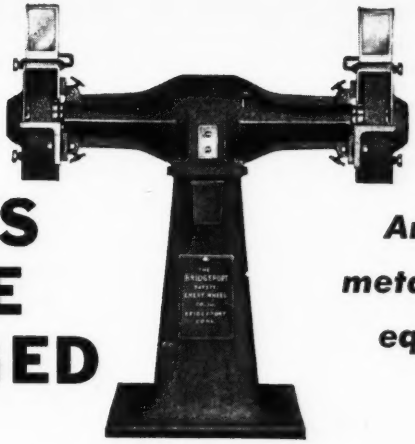


Ethyl Disulphide

It will be noted that a sulphur is joined onto another sulphur.

The author would like to thank Mr. W. Jordan Withrow of The City College, New York, for checking the manuscript.

(Conclusion)



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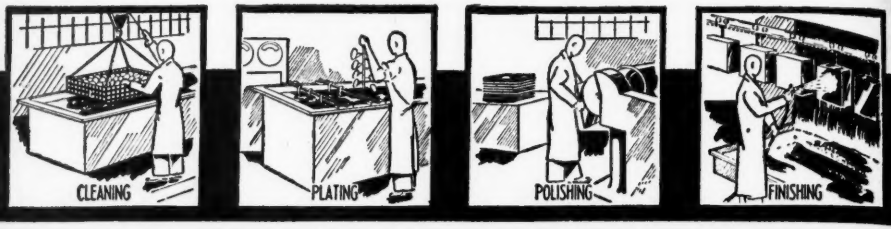


News of the Industry

Zapon Sales Staff Additions

Paul N. Clemens, C. H. R. Carlson, and J. T. O'Gorman have been added to the sales staff of the Zapon Division of Atlas Powder Company in line with the company's present plans for increased production and enlarged laboratory facilities, according to an announcement by J. M. Howard, Zapon general sales manager. The Zapon Division, which manufacturers industrial protective coatings, has its main office in Stamford, Connecticut.

Paul N. Clemens

Mr. Clemens, who will work out of the Stamford office handling sales correspondence and sales development follow-up, formerly was assistant sales manager of the Heresite & Chemical Company, Manitowoc, Wis., and later office and laboratory manager for Bishopric Products Company, Cincinnati, Ohio.

Assuming charge of the metal precoating section of the Zapon Division, Mr. Carlson comes from the Military Planning Division of the Office of Quartermaster General where he was head of the Paint and Varnish unit, plastics section of the research and development branch. He previously served with the Sherwin-Williams Company, Chicago; North American Paint Company, Los Angeles; and Pittsburgh Plate Glass Company, Chicago.

Mr. O'Gorman, formerly laboratory manager for Maguire Industries, has been placed in charge of the packaging section of the Zapon sales department Before becoming associated with Maguire Industries, he was employed as a Zapon chemist.

Markley Appointed General Sales Manager of Sun Oil

The appointment of Frank R. Markley as general sales manager of the Sun Oil Company is announced by Samuel B. Eckert, vice president in charge of marketing. Mr. Markley, formerly manager of the company's industrial products department, will serve as assistant to Mr. Eckert in the conduct of all sales activities.

Mr. Eckert also announces the appointment of Maximilian H. Leister as general manager of Sun's motor products department. Ray H. Anders has been appointed to succeed Mr. Markley as

manager of the industrial products department. Mr. Anders has been assistant manager of the department since September 15, 1944.

After joining Sun Oil Company as a lubrication engineer in the New York district in 1920, Mr. Markley became New York manager of industrial oil sales and later special representative in the general sales department in Philadelphia. In 1933, he was appointed general manager of the export department, directing the company's marketing activities throughout the world. Prior to joining Sun Oil, Mr. Markley was associated with the Westinghouse Electric Corporation in the power equipment sales department.

Mr. Leister joined the company as assistant advertising manager in 1921, became manager of motor products sales in the Philadelphia district on April 1, 1924, and on December 1 of the same year was appointed general manager of the motor oil division and director of advertising.

Mr. Anders is a graduate of Pennsylvania State College where he received a Bachelor of Science degree in chemistry. He was first employed by Sun Oil as an industrial products salesman in the Trenton, New Jersey district in 1929, and became manager of industrial products sales in the Philadelphia division in 1937.

Adopts Uniform Packaging

Charles Lohman, sales manager of the Pemco Corp., Baltimore, Md., announces a new and brighter series of containers for all Pemco products. Designed so as to increase the ease of identification, the containers, in addition, are so colored as to permit a uniform resemblance throughout the entire line—from the half-pint sample can to the 100-lb. frit bag.

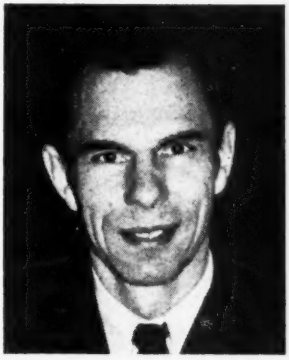
George W. Burgesser Passes

According to an announcement received, George W. Burgesser, for many years with the Standard Varnish Works and for the past ten years employed by Valentine & Co., Inc., at its Kearney plant where he was assistant to the superintendent, passed away recently at the age of 73.

Mr. Burgesser was recognized as an outstanding figure in the country on blacks and was highly regarded in the trade.

Noted Discoverer Visits Wyandotte Chemicals Corporation

Dr. Glenn T. Seaborg, co-discoverer of plutonium and elements 95 and 96, recently visited the plants of Wyandotte Chemicals Corporation. He was the guest of Dr. Roy E. Heath, manager of industrial sales of the J. B. Ford Division, who was loaned by Wyandotte Chemicals to join Dr. Seaborg's staff on the famous Manhattan Project.



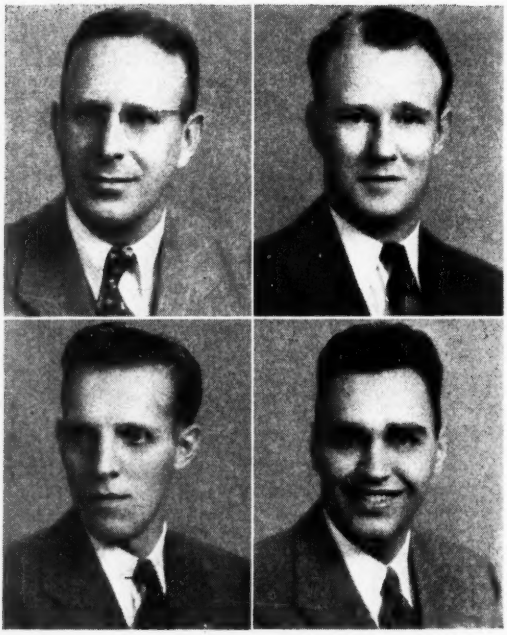
Dr. Glenn T. Seaborg

Dr. Seaborg astounded his hosts by stating that there is as much energy in a little more than half a pound of plutonium as is derived from the hundreds of tons of coal used each day in the mammoth Wyandotte Chemicals plants.

A.E.S. Newark Branch Spring Meeting

The annual Spring open educational meeting of the Newark Branch of the A.E.S. is scheduled to be held on April 5, at 7:30 p. m. at the Robert Treat Hotel in Newark, N. J. This is the third of a series of three open meetings sponsored by the Newark Branch yearly.

The speakers and subjects to be presented are as follows: Myron Diggin, Hanson Van Winkle-Munning Co., Matawan, N. J., Subject—to be announced; M. R. Murliss, Monroe Calculating Machine Co., Subject—Finishing of Steel; Dr. G. K. Soderburg, Graham, Crowley & Associates, Inc., Subject—Evolution of Plated Coatings.



(Upper Left) John M. Krings, (Upper Right) Gene J. Schwarber, (Lower Left) George E. Hay, (Lower Right) Richard S. Kline

•

George E. Hay and Richard S. Kline have also been recently discharged from the armed forces and have returned to Gardner Publications to resume their duties as representatives. A graduate of New York University, Mr. Hay will serve as Central Western Manager and will work out of the Cincinnati office. Mr. Kline, Western Manager, will have his headquarters in Chicago.

George H. Meyers, former Western Manager, is retiring from active duty though still retaining some contacts in the Chicago area.

John M. Krings Named General Manager of Gardner Publications

Don G. Gardner, President, announces that effective February 4, John M. Krings, former Advertising Manager, has assumed the duties of General Manager of Gardner Publications, Inc., publisher of PRODUCTS FINISHING, MODERN MACHINE SHOP, EL TALLER MECANICO MODERNO, and OFICINA MECANICA MODERNA.

A graduate of the University of Wisconsin, Mr. Krings became associated with Gardner Publications on February 1, 1932, assuming the position of Advertising Manager. He held this position until his recent appointment as General Manager of all activities of the company.

Gene J. Schwarber, recently discharged from the U. S. Army, has returned to Gardner Publications where he assumes the duties of Advertising Manager, succeeding Mr. Krings. Mr. Schwarber, who was in the service more than two years, part of which time was spent overseas in the European theater, came with the company in November, 1936.

Goodyear Heads Glyco Chicago Sales Office

Glyco Products, Inc., has announced the opening of its new Chicago sales office at 30 N. Dearborn St., Chicago 2, Ill. This office is under the personal supervision of Dr. George H. Goodyear who has been closely associated with the technical sales development of the company's products for many years subsequent to receiving his Ph.D. at Northwestern University.

Assisting Dr. Goodyear in the technical sales of emulsifying agents, polyhydric alcohol esters, synthetic waxes, and other special chemicals in the Chicago industrial area are David J. Dean and Paul Sanderson. Both of these men have had many years of experience in the chemical field. Mr. Sanderson is a graduate in chemistry of the Massachusetts Institute of Technology and for the past several years has been attached to the technical staff of the Mine Safety Appliances Company in Pittsburgh. Mr. Dean is a graduate of Akron University and has been recently engaged in research in the laboratories of the Columbia Chemical Division of the Pittsburgh Plate Glass Company.

FASTER AND BETTER . . .

INSULATION FOR PLATING RACKS

MICCROTAPE
MICCROTUBE
FOR INSULATION OF PLATING RACKS FOR MASKING PARTS PRIOR TO SELECTIVE PLATING
MICHIGAN CHROME & CHEMICAL COMPANY
MICCRO Products

Throughout the plating industry MICCROTAPE and MICCROTUBE are recognized as unexcelled (1) for the protection of plating racks (2) for masking parts prior to selective plating . . . They are perfect insulators—easily applied—unaffected by cleaning solutions—economical to use.

⬅ MICCROTAPE

An extruded tape with tapered edge (an exclusive feature) which permits much smoother overlapping, closer fit in grooves and around shoulders, making it particularly adaptable in hard chrome plating. Quickly applied—no heat sealing necessary. Has high dielectric strength, remains tough and permanently elastic.

MICCROTUBE ⬇

An extruded tubing with the same physical and insulating characteristics as Miccrotape. Speedily applied to straight and bent contact wires, also round splines which may be drilled later for contact wires. Used in conjunction with Miccrotape, the two being fused together to form a perfect leakproof coating. Available in inside diameters from $\frac{1}{16}$" to 1".

Write for six page bulletin giving complete information and prices.

Manufactured and Developed by Experienced Platers

MICHIGAN CHROME and CHEMICAL COMPANY

6340 East Jefferson Avenue · Detroit 7, Michigan

Craven Returns to Pemco as Plant Superintendent

The Pemco Corp., Baltimore, Md., announces the return of Capt. Henry E. Craven to the company as plant superintendent. In 1932, Capt. Craven graduated from the University of North Carolina with a degree of ceramic engineer. Immediately upon his graduation, he joined Pemco as a ceramic engineer in the Control Department and, at the outbreak of the war, had advanced to the position of plant superintendent. He then enlisted in the Chemical Warfare Service and was immediately sent to CWS Laboratories of Columbia University for research work. From New York, Capt. Craven was transferred to the Engineering Division of the Technical Command at Edgewood Arsenal and remained there until his discharge.

Sales Engineers Named

The Zapon Division of Atlas Powder Co., Stamford, Conn., announces the appointment of Ralph C. Peck and Roy S. Steeley as sales engineers in connection with its current expansion of sales personnel.

Ralph C. Peck

Mr. Peck, who has been assigned to cover industrial accounts in Eastern New York State, formerly was engaged in the paper manufacturing and distribution fields. During the war, he was purchasing agent for Bagley & Sewall, Watertown, New York.

Mr. Steeley, who has been assigned to Western New Yark State, previously was assistant plant manager of the Stamford Electronic Division of Maguire Industry. He also has served in the mechanical research and development engineering fields.

Roy S. Steeley

Appoints New Director

The McLain Organization, advertising and sales planning organization, Philadelphia, announces the appointment of John O'Hara Harte as director of public relations and plans. The organization also announces the formation of a public relations department to service its clients, as well as additional outside business.

After serving for 10 years with The Evening Bulletin, Philadelphia, Mr. Harte entered the public relations and advertising business. He has been director of public relations of the Philadelphia Housing Authority and manager of advertising and public relations, Curtiss-Wright Corp., Propeller Division, Caldwell, N. J. He was also account executive for Steve Hannagan Associates, New York; account executive for N. W. Ayer & Son, New York; and executive for Young & Rubicam, Inc. For the past three months, he served under contract with Menasco Manufacturing Co., Burbank, Calif., to organize a department of advertising, public relations, and internal relations for that company.

TROXIDE

MAKES "BRIGHT-DIPPING" SAFE

- **ELIMINATES MIXING-HAZARDS**
- **NO DANGEROUS FUMES . . . EQUIPMENT AND PERSONNEL PROTECTED**
- **NO SPLASH-BURNS**
- **SAFELY, EASILY STORED**

FOR THE FULL STORY of this *safe*, new method of "Bright-Dipping," just write "Troxide" across your business-card or letterhead, and mail. Troxide is revolutionary . . . because it offers an amazing degree of safety . . . plus an efficiency that meets *specific* job-requirements.

Troxide Bright-Dip Formulae eliminate the hazards commonly present in the conventional bright-dip formula. No "splash-burns" from accidental splashing . . . no dangerous, corrosive fumes. In addition, Troxide Formulae will give you the degree of brilliance your metal-finishing job requires.

Troxide . . . a scientifically developed compound of dry, inert chemicals . . . becomes active *only* when dissolved in water. Therefore, it can be handled and stored easily, safely . . . to be used in quantities demanded by *specific* jobs. That's why Troxide solutions are so economical . . . so easily prepared.

LET US HELP YOU SOLVE *YOUR* BRIGHT-DIP PROBLEM

TROXIDE

SUPPLIERS:

South, Midwest and West:
Waverly Petroleum Products Co., Drexel Bldg., Philadelphia 6, Pa.

East:
Safety and Maintenance Co., Inc., 601 W. 26th St., New York 1, N. Y.

Dehn Appointed Sales Manager

Edward Magnuson, president of The Magnuson Products Corporation, manufacturer of industrial cleaning compounds, announces the appointment of George W. Dehn as sales manager. Mr. Dehn has been connected with the cleaning, plating, and finishing industry, having traveled through the Mid-West for the past 20 years, representing the Zapon Company, Division of Atlas Powder Company. He will be located at the home office of the Magnuson Products Corporation at 50 Court St., Brooklyn 2, N. Y.

New Sales Representatives Announced

Mass & Waldstein Co., Newark, N. J., manufacturer of lacquers, enamels, synthetics, and specialty finishes, announce the appointment of C. B. Knepper and C. R. Peterson as sales representatives operating out of the Chicago office. Mr. Knepper will cover a portion of Chicago and the state of Wisconsin, while Mr. Peterson's territory will be another part of Chicago and the state of Michigan.

A.E.S. Milwaukee Branch Annual Educational Meeting

The Milwaukee branch of the A.E.S. is again holding its annual Education Meeting and Banquet at the Schroeder Hotel on April 20, 1946. The speakers for the Educational Meeting to be held at 2:00 p. m. are W. L. Pinner, president of the A.E.S., Dr. R. Saltonstall of The Udylite Corporation, and Dr. Walter Meyer of The Enthone Company. Their subjects will be announced later.

Superintendent Named

Leonard T. Beale, president of the Pennsylvania Salt Manufacturing Company, announces the appointment of James McWhirter as superintendent of Pennsalt's Natrona plant. Mr. McWhirter, who succeeds Charles G. Boone, retired, came to Pennsalt last summer after eight years of experience in the heavy chemical industry. Before joining Pennsalt in Philadelphia, he had been superintendent of plants in Detroit and Cleveland for the General Chemical Company.

TANKS
for Many Purposes

- Plating
- Anodizing
- Oxidizing
- Rinsing
- Cleaning
- Acid Solutions
- Alkaline Solutions
- Wood Tanks
- Steel Tanks
- Ceramic Tanks
- Unlined Tanks
- Tanks lined with asphalt
- Tanks lined with lead
- Tanks lined with rubber
- Tanks equipped for heating
- Tanks for practically any style for Metal Finishing

MUNNING & MUNNING, Inc.

Designers *Engineers* *Manufacturers*

Electroplating Equipment and Supplies

202-208 Emmett St., Newark 5, N. J.

New York Philadelphia Woonsocket, R. I.

Iridite Offers a Fast, Sure Way to Lick Corrosion in Zinc, Cadmium, Galvanizing!

From every angle . . . Iridite gives you an anti-corrosion agent that will boost sales appeal and profits in your zinc, cadmium and galvanized products. *It's this simple:* Immerse your parts manually or automatically—in single racks or bulk—for only 15 to 60 seconds—in an Iridite solution. Iridite does the rest—while maintaining automatic machine cycles—and dries in a few seconds for immediate handling, packing and shipping.

Use Iridite as a final protective finish . . . as a paint base for permanent adhesion . . . as a cost-cutter in combination with galvanizing or zinc plate to replace more expensive materials. Iridite *unites chemically* with the metal . . . won't chip, flake or peel . . . won't alter dimensions.

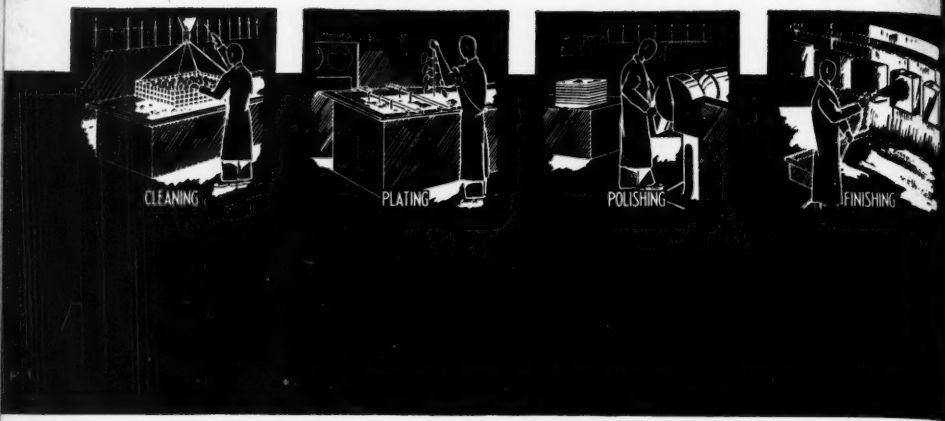
Currently available in eye-appealing red, green, blue, bronze, olive drab, black and transparent Iridite-Bright. Check Iridite's performance for yourself. Send for free test panel . . . half Iridited, half unprotected. Rheem Research Products, Inc., 1493 Standard Oil Building, St. Paul and Franklin Streets, Baltimore 2, Maryland.

BRANCHES — 570 Lexington Ave., New York 22; 20 E. Jackson Blvd., Chicago 4; 2411 Sichel St., Los Angeles 31. Distribution in: Waterbury; Grand Rapids; Detroit; Los Angeles; Long Island City.
Reg. U. S. Pat. Off.

RHEEM RESEARCH PRODUCTS, INC.

IRIDITE

Standard Oil Bldg., Baltimore 2, Md.



Kelite N. F. Paint Remover

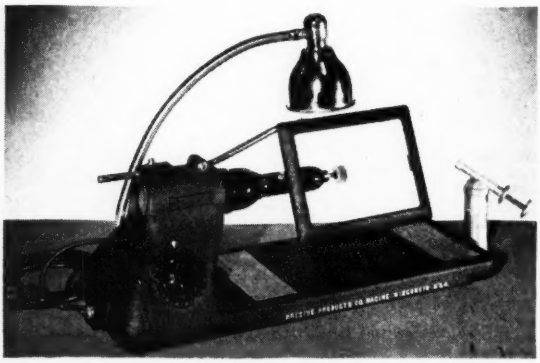
A non-inflammable remover for use in the speedy removal of all types of paint and enamel has been made available by Kelite Products, Inc., 909 E. 60th St., Los Angeles, Calif. Designated as Kelite N. F., the material can, it is claimed, be used with complete safety on all metals and is supplied packed in 5, 15, and 55-gallon containers.

According to the manufacturer, as many as eight coats of paint can be penetrated, loosened and removed in one step using Kelite N. F. Remover, a period of not longer than 30 minutes being required. Complete removal of one or two coats can be accomplished in 10 minutes, it is stated. Removal after penetration is said to be easy in that the paint can be sheeted off by a pressure rinse.

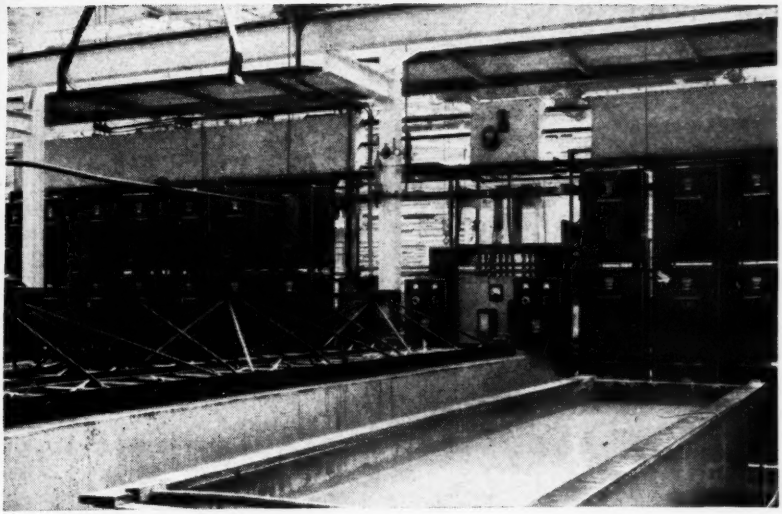
Precise Vari-Speed Lathe

A small high speed lathe for use on a bench or table in grinding, finishing, and polishing small products and parts made of steel, non-ferrous metals, plastics, and other materials, to be known as the Precise Vari-Speed Lathe, has been developed by the Precise Products Co., 1328 Clark St., Racine Wis. Powered by a Precise-35 electric grinder and hand tool, the lathe unit features built-in speed control which provides for a range of working speeds from 0 to 40,000 r.p.m. By turning a handy control dial, speeds can be continuously adjusted from standstill to a top speed of 40,000 r.p.m. The power unit can be detached and used separately as a hand tool for grinding, milling, deburring, finishing, and polishing operations.

The lathe stand is cast of solid aluminum and finished in black crackle. Two large recessed compartments with oak covers provide storage space for rotary tools. An adjustable safety glass shield is included for operator protection, while a large lamp located on a flexible arm serves to illuminate the entire operating field. A small pressure gun allows for quick lubrication of all four high speed ball bearings of the unit.



Precise Vari-Speed Lathe



FOR A FLEXIBLE PLATING POWER SUPPLY USE *G-E* RECTIFIERS . . .

Equip your plating shop with G-E Copper-oxide Rectifiers. It's a sure way to eliminate the expense, costly delays and shutdowns which so often result when production needs change.

They Help You Save Five Ways:

1. G-E COPPER-OXIDE PLATING RECTIFIERS offer a decentralized power source that can be shifted easily and quickly to the exact spot required for peak operating efficiency.
2. G-E COPPER-OXIDE PLATING RECTIFIERS can be arranged in parallel, series or series-parallel for a wide range of voltage and current requirements.
3. G-E COPPER-OXIDE PLATING RECTIFIERS supply transmission control of a-c input instead of resistance control in d-c output. This cuts current cost to the minimum.
4. G-E COPPER-OXIDE PLATING RECTIFIERS are easy to install. They require no special foundation or expensive installation accessories.
5. G-E COPPER-OXIDE PLATING RECTIFIERS have no moving parts other than a ventilating fan which requires occasional lubrication. Hence, maintenance costs compared with other types of plating power equipment are negligible.

Investigate how G-E Copper-oxide Rectifiers can help you realize economies in your plating and anodizing establishments. Write to Section A264-70, Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn. Ask for a copy of our catalog entitled, "G-E Copper-oxide Plating Rectifiers and Controls."

GENERAL ELECTRIC

Cres-Lite Synchrome Aluminum Paint Indicator

A handy pocket-size aluminum paint indicator is now being offered to paint

Cres-Lite Synchrome Aluminum Paint Indicator

dealers, their sales people, and industrial purchasing agents by the Crescent Bronze Powder Company, manufacturer of Cres-Lite Synchrome Aluminum Paint. The indicator is designed to place at the dealers' finger tips information they or their customers might desire regarding the exterior or interior application of aluminum paint.

One setting of the indicator tells (1) how to prepare any given surface before applying the paint; (2) how many square feet of any given surface can be covered with a gallon of the paint; and (3) the kinds of structures having the given surface, which are covered in detail for each possible surface on which aluminum paint can be applied. The indicator has two sides—one side for interior applications and the other for exterior applications.

Requests for the Cres-Lite Synchrome Aluminum Paint Indicator should be addressed on company letterheads to Mr. M. Hexter, Crescent Bronze Powder Co., 118 W. Illinois St., Chicago 10, Illinois.

Aeroil "Midget-6" Plast-O-Dip Tank

Known as the Aeroil "Midget-6" Plast-O-Dip, a portable plastic coating melting tank of one-gallon capacity specially designed for the protective coating of plugs, gages, carbide-tipped tools, and so on, has been brought out by the Aeroil Products Co., West New York, N. J. An outstanding advantage claimed for the unit is the fact that the full compound "load" can be brought to dipping temperature from a cold start in a matter of minutes, thus greatly reducing heat-up time delays.

The Aeroil Midget-6 Plast-O-Dip Tank features a one-piece inner vat of heavy warp-proof cast aluminum of high heat conductivity which is said to result in complete uniformity in heating plastic coatings. Additional features of the unit include thermostatic controls for auto-

"PRODUCTION" TYPE S

Centerless POLISHER BUFFER SURFACER

Polisher, buffer, surfacer and vertical or horizontal belt grinder, with centerless feed are all combined in the "PRODUCTION" TYPE S machine. Ideal for cylindrical polishing or straight line finishing on flat work. Can be used for anything that can be ground or polished—metals, rubber, fibre, wood, etc.

Write for Illustrated Folder

PRODUCTION MACHINE CO. • GREENFIELD, MASS.

ANOTHER HARSHAW DEVELOPMENT FOR BETTER PLATING

NEW SINGLE NICKEL SALTS

small definite crystals

NOT A POWDER

This photograph, at five times magnification, shows the uniformity of crystal size.

A unique process, developed by Harshaw, now makes it possible to produce single nickel salts as small definite crystals of carefully controlled size. Advantages, when compared with the larger crystals formerly produced, are numerous.

- **Uniformly Small Crystals . . . Not a Powder** —Harshaw's unique manufacturing process controls the uniformity of crystal size and shape.
- **High Purity . . . High Nickel Content**—These uniformly small $NiSO_4$-$6H_2O$ crystals are the purest, highest nickel content nickel salts we have ever made.
- **Rapid Solubility** — Small crystals provide a large surface area. Solubility is rapid, saving time and trouble in preparing solutions.
- **Free Flowing**—When kept under reasonable storage conditions, these salts remain free flowing—lumping and caking are eliminated.

Harshaw is ready to help you with this new development for better work. Order now from your nearest Harshaw branch.

***New* SHIPPING PACKAGE**

This new type of nickel salts now makes possible the use of strong 5-ply paper bags containing 100 lbs. net. Easy to handle — they stack conveniently and pour in a free flowing stream.

HARSHAW

THE HARSHAW CHEMICAL CO.
1945 East 97th Street, Cleveland 6, Ohio
BRANCHES IN PRINCIPAL CITIES

matically maintaining the heat at the required temperature; removable cover

Aeroil "Midget-6" Plast-O-Dip Tank in Use

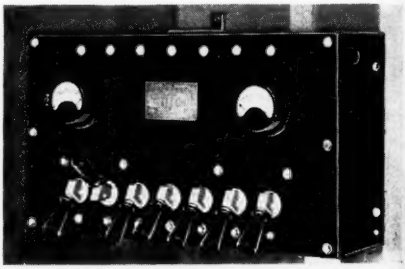
with insulated plastic knob handle; neon pilot light for swift visual check; and handy carrying handle.

The Aeroil Midget-6 weighs 16½ lb. complete and is equipped with 1,000-watt elements which are connected by a standard two-prong plug. Since the total current requirements are equivalent to that of an ordinary domestic iron, no special fuses or wiring is necessary in using the tank, it is claimed.

Udylite Plating Rheostat

Developed to provide accurate current control, efficient heat dissipation, maximum operating efficiency, and long continuous service under plating room conditions of high humidity, acid fumes, and vapor, a rheostat for close tolerance plating is now being marketed by The Udylite Corp., 1651 E. Grand Blvd., Detroit 11, Mich. All switches of the unit are of the self-cleaning cam type which is said to assure clean, efficient contacts every time the swtiches are closed. All metal parts are Udylite-cadmium plated to prevent corrosion.

The Udylite Plating Rheostat is available in standard sizes ranging from 15 to 5,000 amperes and in voltage drops from 1 to 5. Special rheostats can be provided on order.



Udylite Plating Rheostat

ALLWOOD

"Vienna Brand" Lime

Made from Limestone that is identical in chemical analysis and geological structure with European Imported Lime. Tests show a "lime cake" made from Allwood "Vienna Brand" Lime equals the finish made from imported lime.

WRITE FOR FULL PARTICULARS

ALLWOOD LIME COMPANY

Manitowoc • Wisconsin

Those Perfect Partners For Pickling

NEP and SUMFOAM

• TO SAVE ACID IN PICKLING •

• TO PREVENT FUMES •

THE WM. M. PARKIN CO. • 1102 HIGHLAND BLDG.

PITTSBURGH 6, PA.

Clean Spray Booths

Spray BOOTHCOTE on clean booth.
Paint peels off in sheets.
NO SCRAPING—SAVE TIME and LABOR
Trial offer 5 gal. $5.50 F.O.B. Buffalo
Used by 2000 leading manufacturers.
MONEY BACK IF NOT PLEASED.
Write for Circular.
HYGRADE FOOD PRODUCTS CORP.
HARRIS SOAP—BOOTHCOTE DIV.
19 Stetson St., Buffalo 6, N. Y.

USE

McKeon's
"Liquid Sulphur"

• for producing black oxidized finishes on copper and silver. Is simple and easy to use:—fool-proof in operation. Does not deteriorate in stock. Gives chemical control of oxidizing solution.

(Always shipped on approval)

Sample FREE
Guaranteed

Sulphur Products Co.
GREENSBURG, PA.

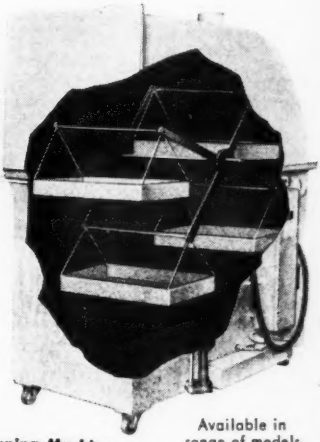
CLEAN METAL PARTS PERFECTLY

60% FASTER

with Phillips *ROTOMATIC* VAPOR DEGREASER

- Cleans thoroughly and economically with Phillsolv non-flammable solvent.
- Lowest Toxicity.
- Completely automatic timer and limit switch governs cycle of cleaning.
- No shut-downs to distill solvent.
- Completely hooded, with exhaust stack and hanging door.
- Automatic safety features.
- Equipped with flusher pump and hose.

RECLAIMS ITS OWN SOLVENT WHILE OPERATING



Available in range of models and capacities up to 3,000 pounds of work per hour. Write for complete details.

Manufacturers of a Complete Line of Metal Cleaning Machinery

PHILLIPS MANUFACTURING CO.
3439 W. TOUHY AVENUE CHICAGO, ILLINOIS

Optimus Floor Cleaner No. 1F10

Designated as the No. 1F10, a heavy duty floor cleaning compound, especially compounded for use on cement, Terazzo, or tile floors has been announced by the Optimus Detergents Co., 132 Church St., Matawan, N. J. Although very effective in removing oil, grease, and other dirt from the surface, the material does not harm the finish in any way, it is claimed.

Optimus Floor Cleaner No. 1F10 is a base from which a liquid floor cleaner can be made, or it can be applied to the surface directly and then rinsed off. Used in lower concentrations, it is said to be very effective in industrial floor scrubbing machines. The cleaner is available in 150 and 500-lb. containers.

StaSafe Face Shield

A face shield featuring a phosphor bronze spring retaining clip which is said to lock the visor fimly in position has been added to the line of StaSafe equipment offered by the Standard Safety Equipment Co., 232 W. Ontario St., Chicago 10, Ill. The simple operation of replacing the visor can be performed without tools or fasteners by merely lifting the retaining clip and sliding the new front into place.

In addition to the quick-change visor feature, the StaSafe Face Shield is light in weight and is sturdily made to provide safe, comfortable protection to the face and eyes wherever they are exposed to flying particles, sparks, and the splash of acid and molten metal. The shield is available in an open top style designated as the No. 4 and in a covered crown style designated as the No. 5, as shown in the accompanying illustration.

StaSafe Face Shields

GOLD PLATING SOLUTIONS

In All Colors

Guaranteed 100% Pure Gold Content
Troy Weight - Color Constant
Tarnish Resistant
Proven Quality by the Acid Test

Write or call our experts about your plating problems

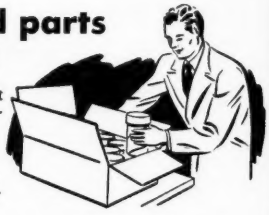
Davis-K-Products Co.
114 Lexington Ave., New York 16, N. Y.
Lexington 2-7360
2-5816

WHAT do your finely machined parts look like at the *receiving* end?

PROTECT fittings, exposed openings, threads, etc., in transit or storage, from rust or other spoilage. Use PRECISION safeguards. External, internal—close fit any shape.

Precision DUST CAPS & THREAD PROTECTORS

Tough fibre, spirally wound. Close tolerances. Won't slip off. Prompt delivery, any quantity. *Write for folder.*



PRECISION PAPER TUBE CO. *Mfrs. of Dielectric Tubes, Bobbins, and Spools* **2053 West Charleston St., Chicago 47, Ill.**

If its metal polishing or metal finishing you want, check LUPOMATIC.

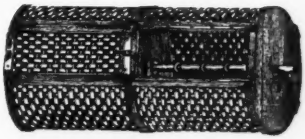
DEBURRMASTER
ACCURATE TO MICROMETER DIMENSIONS

For efficiency in finishing metal parts, install a DEBURRMASTER.

Save time, money and produce assured results.

LUPOMATIC TUMBLING MACHINE CO., INC.
4510 BULLARD AVE. BRONX, N. Y.

Inexpensive, light in weight. Easy to install and operate.



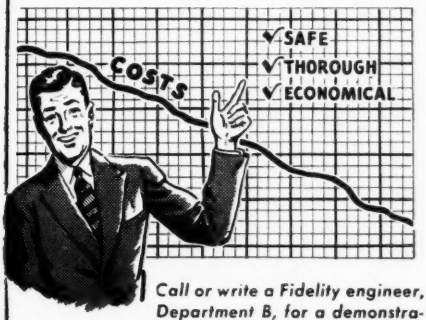
King White-Oak Plating Barrel

becomes a sub-anode, thereby producing a cleaner, brighter plate. Less plating time is required to put on the desired thickness of plate.

Send for catalogue and specification sheets.

JOHN KING 48 SPRINGFIELD ST. DAYTON 3, OHIO

TESTS PROVE . . .



Call or write a Fidelity engineer, Department B, for a demonstration and quotation.

FIDELITY
STRIPPING COMPOUND #120

Fidelity #120 proves its speed, efficiency and economy in shop tests. An emulsion type stripper that completely removes baked or synthetic enamels from *all* metals, including aluminum, magnesium and their alloys, in 3 to 8 minutes.

FIDELITY CHEMICAL PRODUCTS CORP.
430 Riverside Ave., Newark 4, N. J. • Humbolt 3-3640
Serving Industry with Cleaning and Stripping Compounds

"All-Out" Dry Chemical Fire Extinguisher

Designed to combine high efficiency under most conditions with maximum protection to the user and to equipment installations, the "All-Out" Dry Chemical Fire Extinguisher illustrated herewith, product of Pressurelube, Inc., All-Out Fire Extinguisher Division, 609 W. 134th St., New York 31, N. Y., is said to perform effectively under all climatic conditions, in extreme temperatures, and in the presence of winds or drafts.

With the extinguisher, dry chemical is ejected, under pressure, in a flat stream that separates the flame from the burning material. Instantly forming a dense, fire-smothering cloud over a flaming area up to a distance of 18 feet, the chemical creates a solid barrier between the operator and the flame, thus providing protection from radiant heat, it is claimed. On hot metal surfaces, the dry chemical forms an insulated film, thereby helping to guard against dangerous reflash.

Said to meet the requirements of the Associated Factory Mutual Laboratories and Underwriters' Laboratories, the All-Out Dry Chemical Fire Extinguisher, according to the manufacturer, ejects a chemical which forms no toxic gases, is a non-conductor of electricity, non-abrasive, harmless to finished surfaces, and is easily removed with a brush. The extinguisher features a squeeze-grip nozzle for positive chemical control and is light in weight, thus enabling it to be easily carried and used by either men or women operators. Designed for easy refilling without the use of special tools or equipment, the extinguisher is equipped with 26 inches of ½-inch I. D. pressure hose that permits rapid maneuverability of the dry chemical stream.

"All-Out" Dry Chemical Fire Extinguisher

Fulflo Filters. An efficient and economical method of clarifying both alkaline and acid plating solutions is presented in a bulletin file prepared by the Commercial Filters Corp., A and West Third Sts., Boston 27, Mass. Included is a bulletin illustrating and describing the Fulflo filter and honeycomb filter tube, data sheets on the filtration of electroplating solutions, as well as separate bulletins on the various models of Fulflo filters. The bulletin file is offered free to interested individuals upon request.

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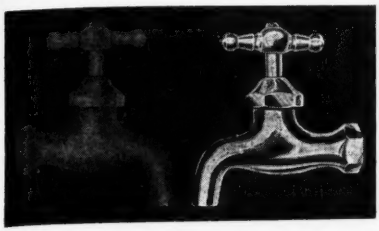

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